JOURNAL OF

Petroleum Technology

Volume 1 JUNE, 1949 Number 6

PROPERTY OF UNIVERSITY LIBRARY JUN 27 1949

In Two Sections — Section 1

TABLE OF CONTENTS

Petroleum Branch — Section 1

GUEST EDITORIAL, by Carl E. Reistle, Jr. 3

HAROLD DECKER, NOMINEE FOR BOARD OF DIRECTORS 4

NOMINEES FOR PETROLEUM BRANCH OFFICERSHIP, 1950 5

OIL AND GAS CONSERVATION — 1949, by Wallace Hawkins 6

NEWS OF LOCAL SECTIONS 9

TECHNICAL NOTES 19

Professional Directory . . . 18 Employment Notices . . . 20

All Institute — Section 2

BOARD OF DIRECTORS' MEETING 201

AIME MEETING SET FOR SEPTEMBER 203

Local Section Notes . . . 205 Drift of Things 206

News of AIME Members . . 210 Directory of AIME Officers . 222

Petroleum Transactions

T.P. 2631 BEHAVIOR OF BINARY, TERNARY, AND MULTICOMPONENT SYSTEMS AT STATES SIMILAR TO THOSE ENCOUNTERED IN CONDENSATE FIELDS, by B. H. Sage and W. N. Lacey . . . 143

T.P. 2641 INTRODUCTION TO INDUCTION LOGGING AND APPLICATION TO LOGGING OF WELLS DRILLED WITH OIL BASE MUD, by H. G. Doll 148

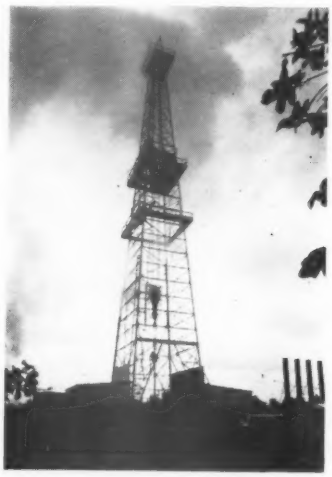
T.P. 2588 PRODUCTION OF OIL UNDER UNITIZATION IN WERTZ DOME FIELD, WYOMING, by E. A. Swedenborg 163

*At 18,734 feet,**

on The Superior Oil Company world's record depth well, Schlumberger made an electrical log in 3½ hours hole time.

Schlumberger made two runs below 18,000′ on The Superior Oil Company's Limoneira No. 1, the new world's record depth well. The first run was made at 18,110 feet and the second on March 13, 1949, at 18,734 feet. Both operations were carried out successfully as routine runs with regular Schlumberger surveying equipment and with a minimum of rig time. Only 3½ hours surveying time was required for each run. Performance of Schlumberger equipment on this new world's record well is proof again that Schlumberger is ready now for your 20,000 foot, or deeper, wells.

*Schlumberger has since logged the Superior Oil Company's Pacific Creek No. 1 — the new record depth well in Wyoming — to 18,704 feet.



SCHLUMBERGER
WELL SURVEYING CORP.
HOUSTON, TEXAS

GUEST EDITORIAL

by

Carl E. Reistle, Jr.
Director, Production Department
Humble Oil & Refining Company

Reservoir Engineering and Conservation

INTERNATIONAL developments during recent years have pointed to the importance of the United States as a controlling influence in world affairs. To a large extent, this position has been reached by the nation's ability to utilize its natural resources to maximum advantage. The oil industry is proud of the manner in which it has discovered and utilized its important resources to support national prestige. That the oil industry has been able to meet the terrific demand for its products is due to the accelerated growth of practices in conservation over the past 25 years. It is now more apparent than ever before that the welfare and security of our country depend to a very large extent on intensified application of means to accomplish the maximum conservation and most efficient use of natural resources, and that petroleum is one of the most important of these resources. Intensified development and application of scientific principles to oil production, beginning in the period following the first World War, has culminated in a new science called reservoir engineering. This relatively new phase of engineering is concerned with the factors that control the recovery of petroleum and thus is an important element in bringing about conservation of petroleum resources.

THERE are several ways in which conservation can be accomplished by the reservoir engineer, who has made great strides toward bringing about higher recovery by utilization of his knowledge of recovery mechanisms and movement of fluids within reservoirs. In Texas the setting of maximum efficient rates of production for the various fields has become an accepted practice. The true MER can be arrived at, however, only after a thorough analysis of the individual reservoir performance. An MER which has been determined by the application of the principles of reservoir engineering will result in the most efficient flushing of oil from the formation on a field-wide basis and the utilization of the most efficient displacement mechanism for primary recovery. Operations under the proper MER may result in doubling the recovery that would be obtained at higher rates. Even though a field is produced at its proper MER, it is often the case that the recovery under the primary operation will leave a large percentage of the original oil in place unrecovered. To improve upon natural recovery, the reservoir engineer has made great progress in determining the most efficient means by which pressure maintenance or secondary recovery may be applied to obtain an additional percentage of the oil in place. Yet another field for the reservoir engineer to practice conservation is in the development and operation of gas condensate pools. A considerable percentage of the nation's hydrocarbon reserves is contained in these gas condensate fields, and analysis to determine the most efficient operating method is necessary. A regulated rate of gas production to maintain reservoir pressure may be indicated or the initiation of a cycling program may prove the most efficient means of preventing underground waste. With today's high drilling cost and with the increasing depth and decreasing quality of new discoveries, conservation can be practiced by the reservoir engineer through the determination of an optimum development and operation program. In this way, the increased profits gained will be available for additional exploration and for the development of low-recovery fields in which profits will be low in any case.

THE reservoir engineer is to be commended for the diligence and integrity employed in the long and arduous task of making the necessary analyses to arrive at conclusions permitting the adoption of sound conservation measures. By wide acceptance of reservoir engineering the state regulatory bodies as well as the industry have indicated their appreciation of the value of this new phase of petroleum engineering in attaining the maximum in conservation. The continued cooperation of the state regulatory bodies and representatives of the oil industry in recognizing and using sound engineering principles will result in the application of accurate maximum efficient rate determinations, reduction to a minimum of the amount of oil left underground, and the adoption of operating methods which will result in benefits to all concerned. Even greater achievements are anticipated as a result of the tremendous oil production research and development program now being carried on in the petroleum industry which will have the effect of further developing the science of reservoir engineering. ★ ★ ★

Harold Decker Nominated to Institute Board

Harold Decker of Houston, general manager of Pan American Production Co. and Pan American Gas Co. has been nominated for a three-year membership on the Institute Board, to begin with the Annual Meeting in 1950.

From his birthplace in Chicago, Harold moved with his parents at a young age to Guthrie, Oklahoma, where he grew up. In addition to the usual boyhood interests he devotedly attended school, and his superiority as a student brought him a scholarship, which took him to Kenyon College. The oil business attracted him, however, and he returned to the Univ. of Oklahoma to study and graduate in petroleum engineering in 1925.

His introduction to the petroleum engineering profession was with the Rio Bravo Oil Co. as a roughneck and roustabout on the Texas Gulf Coast. After a year he joined the Marland Oil Co. to work on pressure maintenance projects in Oklahoma and Kansas, which was then followed by two years with the Tidal Oil Co. as a petroleum engineer.

Leaving that organization in 1931, Harold entered the service of the Skelly Oil Co. as a petroleum engineer in the Tulsa office. Subsequently he became their district supt. for the Texas Gulf Coast with headquarters in Houston. In 1937 he resigned from Skelly to become division supt. in the same area for Seaboard Oil Co., with headquarters at Corpus Christi.

In February, 1945, he resigned his position with Seaboard to become assistant manager of the Pan American Production Co. and the Pan American Gas Co. In August of 1947 he was promoted to his present position of vice president and general manager and a member of the board of the two companies. He has just recently returned to Houston from attendance at the Fifteenth Session of the Advanced Management Program in the Graduate School of Business at Harvard Univ.

His family consists of Mrs. Decker and one daughter who is a student at Lindenwood College at St. Charles, Mo. He has a reputation as a gardener among his neighbors in Houston, and is an ardent salt water fisherman and hunter when he has the opportunity.

Harold has long been active in professional work and is keenly interested in the affairs of the Institute. During 1947 he was chairman of the Gulf Coast Section, and was elected to membership on the Petroleum Branch Committee in 1948, where he still serves. ★

✦ ✦ ✦

George McGhee Appointed U.S. Asst. Secretary of State

George C. McGhee, a Petroleum Branch member who formerly lived in Dallas, was appointed U. S. Assistant Secretary of State on May 26 to be in charge of Near Eastern and African affairs.

A native of Waco, Texas, McGhee graduated from the Univ. of Oklahoma in geology, and then attended Oxford on a Rhodes Scholarship to receive a Ph.D. degree. He was then active as a geologist and geophysicist and formerly was a partner in the firm of DeGolyer, MacNaughton & McGhee in Dallas.

Except for a period of service in the U. S. Navy, he has been in government work since 1941. He entered the State Department in 1946 and later served as a special assistant to Undersecretary of State William L. Clayton. When the Greek-Turkey aid program came along, McGhee was designated to handle it for the State Department, which gave him valuable information and experience for the position he will now hold. In this position he will handle this country's dealings with international organizations operating through the U. N. and the Pan-American Union. ★ ★ ★

NOMINEES FOR PETROLEUM BRANCH OFFICERSHIP, 1950

The Branch Nominating Committee, composed of Irwin W. Alcorn, Basil Kantzer, John Hammond, James Posgate and Charles Pishney, has designated the members pictured on this page as nominees for positions in the Branch government. Article IX of the By-laws calls for publication in June of the pictures and biographies of these nominees. Any group of 25 members may submit additional nominations until August 15. A letter ballot, covering all positions to which the membership has submitted nominations, will be mailed in September. If there are no nominations from the membership by August 15, the letter ballot will be dispensed with and the Nominating Committee's designees will be declared automatically elected. The new officers will be installed at the 1950 Annual Meeting in February.

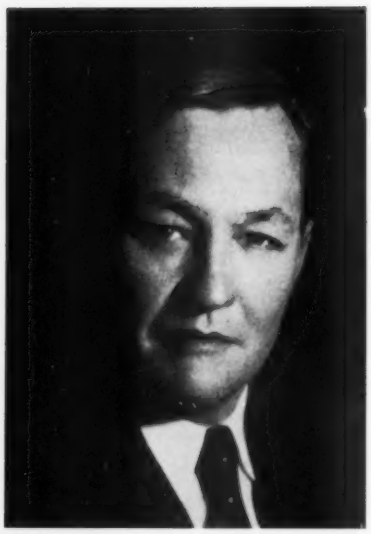
John E. Sherborne for Chairman — A native of England, he moved with his parents to Calif. in 1920 and was naturalized in 1926. After graduating from Calif. Institute of Technology in 1934, he obtained an M.S. in P.E. from the Univ. of Southern Calif. Joining Union Oil Co. of Calif. in 1936, he progressed through several engineering positions until 1945. Since then he has served as division production engineer, chief production research engineer, and is now chief production engineer for the company. He has taught evening classes in production at the Univ. of Southern Calif. since 1940. He has served the Petroleum Branch on the Engineering Research, Special, Production Technology and Executive Committees, and as Branch Vice Chairman in 1949.

Paul Andrews for Vice Chairman — Born in Henrietta, Texas, he moved to Salt Lake City at an early age, attended public schools there and graduated from the Univ. of Utah in 1924. He entered the oil business at Long Beach, Calif. in 1926 in the gasoline division of Standard Oil Co., and changed to production in 1928 as a production engineer with Italo Pet. Corp. He joined Signal Oil & Gas Co. as a production engineer in 1930, and all of his subsequent service has been with that company, where he is now chief production engineer. He has been very active in professional work, serving on several posts for the Conservation Committee of Calif. Oil Producers, the A.P.I. and the AIME. He has served the Petroleum Branch on the Executive Committee, and as chairman of the Pacific Petroleum Chapter.

Richard W. French for Vice Chairman — From his birthplace in Colorado Springs he moved east to attend the Univ. of Delaware, graduating with a B.S. in M.E. in 1929. Joining the Continental Oil Co. in 1933, he served in several posts and places, and while doing so did graduate work at the Univ. of Southern Calif. from 1936 to 1938. His work in engineering took him to top posts in the production and drilling department of Continental, and then to chief engineer for the company. He was then appointed as assistant to the production vice president of Sohio Pet. Co. in Oklahoma City, and in 1947 was promoted to this vice presidency with offices in Cleveland. He has served the Branch as Chairman of the Production Technology Committee in 1948.

R. C. Earlougher for Executive Committee — After graduating from the Colorado School of Mines in 1936 in petroleum engineering, he joined the Sloan and Zook Co. of Bradford, Penn. In 1938 he and a partner purchased the Geologic Standards Co. of Tulsa. The company has operated a large core analysis laboratory, with the principals doing consulting work on water flooding installations and operations. In 1945, he purchased the partner's interest, and has since operated the company under the name of Earlougher Engineering. He has been active in the A.P.I. and I.P.A.A. in addition to his service for the Petroleum Branch, which was as past chairman of the Mid-Continent Section, and member and past chairman of the Branch Publications Committee.

John R. McMillan for Executive Committee — At an early age he journeyed from his birthplace of Vermont to Los Angeles, where he was reared and attended the Univ. of Calif., later transferring to the Calif. Institute of Technology and graduating there in 1931. He joined the Barnsdall Oil Co. then, and in the course of the next 12 years progressed from roustabout to production foreman, and to the land and geological dept. In 1943 he affiliated with the Fullerton Oil Co. as a petroleum engineer, soon became manager of field operations, and in 1947 vice president in charge of production. He is active in the A.P.I., the A.A.P.G., and the AIME. He has served the Petroleum Branch as chairman of the Pacific Petroleum Chapter in 1947.



OIL AND GAS CONSERVATION . . . 1949

By Wallace Hawkins
Vice President and Chief Counsel
Magnolia Petroleum Company

The American System

The gold miners of 1849 were without law. They took matters in their own hands, adopted and enforced rules and regulations of their own making relating to the possession and working of their discoveries. The "customs of the diggings" constituted their self-made law. After eighteen years, this system of regulation became the law of the land. Today, eighty-three years later, these rules and regulations, practically unchanged, remain the current and existing system of law governing mining operations.[1]

After twenty-five years of trial and error, successes and failures in separate state laboratories, the oil and gas producer has discovered and established rules and principles for the development and operation of oil and gas reservoirs designed to prevent waste, protect correlative rights, and protect the public interest. These rules and principles have been enacted into statutory law and promulgated as rules and regulations of state regulatory bodies. This system of regulation for the oil and gas producer is the "custom of the diggings" for the miner. Our general term is conservation.

Our system of conservation of oil and gas was not proclaimed in one grand design by planners from above. It emerged as an alloy from the crucible of rugged experience. Oil and gas law and lawyers muddled along for many years with extemporized rules based on analogies to the common law relating to birds, bees, and waters.

Our heritage of constitutional property rights was the bridgehead of opposition to the effective regulation of oil producing activities. One witness, testifying as late as 1939 before the Temporary National Economic Committee, said that "the new conservation system was an old-fashioned oil squeeze play." A federal judge considered the slow moving effort to bring order out of chaos in the producing business as a "thinly veiled pretense to prevent physical waste" and in reality a conspiracy between the oil producers and regulatory officials to set on foot a plan to increase price. One state judge lapsed into bizarre billingsgate. He opined that "proration of oil was born out of monopoly, sired by arbitrary power, and its progeny (such as these orders) is a deformed child whose playmates are graft, bribery, and corruption." Moreover, those who were bold enough to suggest a law or regulation were not sure that the suggestion would work. It was always feared that any regulation would be the spawning bed of countless rackets. The very purpose and object of regulation was obscure and blurred. The slow moving courts left uncertainty and doubt where certainty was desperately needed.

The Influence of Science

The late arrival of science and the scientific man in the producing business in large measure accounts for the slow, erratic, and boisterous development of our conservation system. When these scientific gentlemen began to appear in the oil fields, their conceptions slowly but surely became the common talk of the oil man. More or less unwittingly, attention was focused on structure, porous rock, oil does not and cannot produce itself, water and gas are producing energies and agencies, reservoirs, reservoir producing characteristics, waste of oil and gas, waste of producing energy, ultimate recovery, reserves, reservoir control, and regulation. The fog began to disappear and progress was on its way.

The final conception spotlighted the reservoir. It was finally recognized that the reservoir constituted a distinct mechanism with its own producing energy, a common source of power for all producers in the field, that such common power and energy was of itself inadequate and insufficient without artificial aid to produce all of the oil and gas. It was not long before peculiarities, eccentricities, and observed phenomena were reduced to stated principles. Producers came slowly though perhaps unwillingly to understand and

---

Address delivered before North Texas Section of AIME, January 5, 1949.
[1] References given at end of paper.

accept the pronouncements of the engineers. It was certain that the book oil man was to be accepted only when he proved himself.

There were many who were skeptical about these so-called laws of nature and nature's habits. It seemed too academic. There were those who doubted the sincerity of the expert and scoffed at his conclusions. In many instances, false doctrine supported by quacks gained temporary vogue. Even in our time it will come to be admitted that the war experiences with PAO 11 in allocating material for the drilling and completion of needed wells furnished the most tangible and visible proof of the benefits and economies of orderly drilling in the oil producing business.

In later years, still in a climate of suspicion but with greater knowledge and more intelligence, our law makers and regulatory bodies were able to devise and employ better designed regulatory techniques and practices. These laws and regulations more often emerged from experience and were bottomed more frequently on scientific principles and known and understood habits and characteristics of producing reservoirs.

In 1938 there appeared under the auspices of the American Bar Association a volume which undertook to describe the method, devices, and techniques then employed to regulate and control the oil and gas producing business in nine states. In January, 1949, the American Bar Association released a new volume entitled *Conservation of Oil and Gas, a Legal History — 1948.* This volume describes the progress and attainment of conservation during the last ten years in thirty-five states. There is a rather comprehensive description of the legislation, administrative rules and regulations, and judicial interpretation for each producing state. One section is devoted to fundamentals of reservoir behavior, as it has come to be generally accepted that engineering principles and natural laws are the essential foundation for all intelligent legislation, rules and regulations, and judicial interpretation relating to the conservation of oil and gas. It is indeed unfortunate that understanding and familiarity with this intricate system is confined to relatively few legislators, judges, regulatory officials, lawyers, and engineers. These complicated regulations are a mental hazard to most state and federal legislators and governmental officials. Substantial and essential parts of the system are deliberately misinterpreted by professional writers of the jack-of-all-trade type.

It does appear that laws and regulations affecting the oil and gas producing business and their administration fall into a pattern of such uniformity and consistency as to justify consideration and treatment as a distinct identifiable code and system of law. The progress and development in the last ten years demonstrate that the chief theorem of conservation is valid, namely, that artificial assistance to and preservation and utilization of natural reservoir energy are necessary to secure the greatest ultimate economic recovery of oil and gas. This theory constitutes the true focus for the application of man-made regulation. A further conclusion is that many sound conservation principles and techniques are now established by experience that there are available sufficient and adequate proved legislative and regulatory devices and techniques to efficiently accomplish the purposes and objectives of legislators and administrators.

As a final general observation it can be said that conservation as a system of regulation in the United States is probably reaching a mature pattern embodied in local state law, administered and interpreted daily by those in contact and acquainted with the regulated operations, supplemented by the interstate cooperative governmental agency, and supported by the federal hot oil act.[2]

The Market Demand Controversy

It should not be assumed that the regulation of the oil and gas producing business has matured as a finished and complete system, snugly accepted by all acquainted with it. On the contrary, there are areas of controversy still existing in which final decisions and conclusions have not as yet been reached.

The controversy about the use of market demand as a factor or technique in the control of production to prevent waste and to protect correlative rights in the public interest still rages. It is an old story and much has been said on both sides. The importance and effect of restricting allowables to market demand has been exaggerated out of all proportion. So-called economists with social objectives and dubious purposes almost exclusively carry on the opposition to market demand restrictions. These reformers and academic meddlers argue that "market demand has nothing to do with conservation and that to use it as a basis for proration is price-fixing pure and simple."[3] Some of these gentlemen say that "productive control or stabilization based on market demand is essentially a form of monopolistic control supported by the states."[4]

A late immigrant, an integrated professor with a college as a stage prop, asserts that the Supreme Court's declaration that market demand is a valid conservation device is "a premise entirely untenable."[5]

The other side of the case is maintained with equal vigor and argument. Market demand restrictions have limited operation since they apply only to allowable below MER production. The restriction it is said, is merely a satellite restriction operating only within the orbit of the more dominant efficient rate restriction. It is maintained that market demand restriction, to the extent that it can and does operate, has the definite purpose and effect to eliminate wasteful excess storage. It preserves and secures to oil and gas producers the benefits of ratable take, thus prohibiting underground waste. It likewise prevents wholesale abandonment of marginal wells.[6]

Solely as a layman without any pretense, and not as an economist or expert in any social science, I should like to contribute two observations to this controversy. They are simple. In these days of estimated and calculated reserves and expert engineers, it would certainly seem that a barrel of oil on the well side of the choke and a barrel of oil on the battery side of the choke would and do produce the same and identical economic consequences and that each has the same and identical influence upon the price of crude. A barrel of oil on the well side of the choke is safe from those who toil not nor spin. Such a barrel is less sus-

ceptible to manipulation, market rigging, and monopoly than a barrel which has left the battery tanks. It may finally be observed that in times of want and increasing demand the effective and sole restriction on production is the MER, whereas in times of plenty and localized excessive producing capacity market demand restriction on production operates automatically as a legitimate conservation device.

Cooperative and Unitized Operations Problems

Another area of controversy and growth in the oil and gas producing business centers around cooperative producing activities and unitized operations of oil and gas reservoirs.

The wholly-owned and operated oil and gas lease is and has been standard equipment, basic necessity, and the very foundation of the American oil and gas producer. This traditional fact and circumstance dominates the managerial structure of the great American oil companies. In the past part-interest leases were not wanted. Even as to part-interest leases our tradition is that the operator of the lease in practice has exclusive management. It is true, nevertheless, that this hallmark of the producing business is being gradually but surely eroded away. Regulations for the prevention of waste and for the protection of correlative rights contribute to this trend. The requirements for economic and efficient operation of zones, pools, and fields likewise tend to diminish the marked accent which has heretofore been placed on the ownership and operation of an individual lease. If there be unbelievers among you as to this tendency, let me suggest that you accumulate some statistics on your own operations. It will be of interest for you to ascertain the number of exploratory wells in which you jointly participated with others or in which you gave or received dry hole money. You should ascertain what percentage of your daily production is derived from joint, part-interest, and unitized leases and operations as compared with the percentage derived from wholly-owned leases. A catalogue of the pooling contracts for the year will give you an idea of the extent of your cooperative drilling and producing activities. It may be of interest too for you to calculate what part of your reserves is situated in wholly-owned and operated leases and what percentage is found in part-interest and unitized leases. Most of us would be surprised at the extent of our cooperative activity in drilling and producing operations.

Voluntary and so-called compulsory untization, both directly and indirectly, is now an established feature of our industry and a distinct conservation device and technique. Undoubtedly the future will more definitely define the proper place and scope of unitized operations in the oil business. There is opposition and some resistance to this scheme. One witness testified that "unitized operations in oil fields, which in fact means monopolized operations, constitute a unified operating interest whereby everybody but the monopolizers get crucified."[7] The literature on the subject, especially since the war, is voluminous. The AIME has been particularly prolific since 1930.[8]

A few statements will serve to localize the chief points of controversy relating to this conservation device and producing method:

1. Actual experience to date is that so-called compulsory unitization actually compels only very timidly and weakly. Producers who have failed to secure voluntary unitization of a particular field or pool have found that governmental power and authority to compel action resides in the custody of elected public officials who are under the usual democratic pressures and restraints and are quite sensitive to royalty owners and minority groups. So far these administrative agencies have used their governmental power sparingly and with the utmost precaution.

2. The resistance of the independent producer and small leaseholders to unitized operations arises out of a fear of excessive operation costs and inability to evaluate a unit interest offered in exchange for a wholly-owned lease. The bankers have not yet learned with confidence to lend money on a unit interest with the same facility and ease with which they make loans on wholly-owned leases. Many independent operators, however, are beginning to see that the way to remain in the oil and gas producing business in times of high prospecting and exploratory costs and expensive and almost prohibitive deeper drilling is to convert wholly-owned leases into unit interests in a cooperative project. It is fair to assume that those producers who believe they are annointed with a genuius for production may have an opportunity to exercise their talents on an operators' committee with as much freedom as they do on a wholly-owned lease. Participation in management through an operators committee at least furnishes an outlet for the pride of ownership.

3. Both the attorneys general of our state and of the nation now question the legality of certain particulars of customary unitized operations. State oil and gas regulatory bodies insist that unitized operations in many instances are required and necessary to carry out a state policy of conservation and the prevention of waste. The exterior boundaries of permissible non-taxable unitized operations have been recently established by the Bureau of Internal Revenue. We may expect the perimeter of permissible cooperative activities to be reliably defined by law and court decisions within the immediate future if not within the year.

The Petroleum Engineer and Geologist

As has been observed, the petroleum engineer and geologist are the leading characters in the growth and development of modern production regulations and the American system of conservation. Collecting data, making studies, reporting evaluations — appraisals, ascertaining and determining producing characteristics, calculating reserves, selecting drilling patterns, fixing oil and gas ratios, determining the boundaries of producing sands, recommending secondary recovery operations, selecting methods and practices of production, etc., fall heavily on their shoulders. Intelligent management can scarcely exist without them. The role of these scientific men becomes even more complicated and treacherous in the matter of determining feasibility for large-scale, unitized, and cooperative undertakings. Coordinated and consolidated engineering and geological estimates and prospects with a high degree of accuracy are essential and required. Indeed these

sciences are subjected to onerous daily tests.

Perhaps the most outstanding contribution to the intelligent, orderly, and sensible production of oil and gas in the last few years has been the establishment and operation of engineering committees by operators for pools, zones, fields, and regions. This instrumentality alone has done more for the advancement of good conservation practices than any other single agency.[9]

I would, however, issue a word of warning. Since so many business decisions rest heavily on your shoulders and, since the whole structure of our conservation system depends on your sciences, you must not depart from your role as a man of science devoted, without benefit of clergy, to the "truth, the whole truth, and nothing but the truth."

References

1. "Mining Law in Recent Years," William Colby, 33 *California Law Review* 368, September, 1945; 36 *California Law Review* 355, September, 1948.
2. *Conservation of Oil and Gas, a Legal History — 1948*, American Bar Association, Kingsport Press, Inc.
3. *A.P.I. Petroleum Industry Hearings*, Temporary National Economic Committee, 1942, p. 72.
4. "Control of the Petroleum Industry by Major Oil Companies," Roy C. Cook, Monograph 39, Temporary National Economic Committee, June 15, 1941.
5. *A National Policy for the Oil Industry, Rostrom*, Yale University Press, 1948.
6. *Antitrust Laws and the Conservation of Oil and Gas*," R. E. Hardwicke, Mineral Section, American Bar Association, September 8, 1948.
7. Volume 6, Temporary National Economic Committee, p. 149.
8. See bibliography in *Antitrust Laws et al* v. *Unit Operation of Oil and Gas Pools*, R. E. Hardwicke, American Institute of Mining and Metallurgical Engineers, p. 277; "Unit Operation of Oil and Gas Fields," John C. Jacobs, 57 *Yale Law Journal*, June, 1948.
9. "The Function and Use of Petroleum Engineering Committees," D. V. Carter, American Petroleum Institute, Illinois Basin Chapter, March 1, 1946. ★ ★ ★

Make San Antonio Reservations Now!

About 500 rooms will be available in San Antonio hotels for the Fall Meeting. One of the leading hotels reports that it has already reserved over 100 rooms, and that reservations continue to be made at a rapid rate. It is therefore important to all members planning to attend the Fall Meeting there to make reservations *now* to be assured of a room.

Mississippi Sub Section Activities

By Sam P. Poythress, Jr.

William D. Owsley, technical adviser for Halliburton Oil Well Cementing Co. in Duncan, Oklahoma was the featured speaker for the Sub Section dinner meeting at the Inez Hotel in Brookhaven May 18. The 79 members and guests who attended evidenced a keen interest in his subject, *The Use of the Hydrafrac Process for Increasing the Productivity of Wells*. This method was pioneered by Stanolind Oil & Gas Co., and was fully covered in a paper by J. B. Clark in the January JOURNAL. The method has been used commercially by Halliburton since March, 1949.

Owsley pointed out that the process was initially developed for use in sand wells, but that it is now being applied to other types of formations. The fluid that is used most now is an oil with a sodium soap bodying agent. Other fluids or bodying agents could be used, but crude or refined oil has been most successful for oil wells, and gasoline most successful for gas wells.

Vice Chairman Harold Leeton of Gulf Ref. Co. in Laurel, presided at the business session following the speaker. J. D. Lowry of the California Co. in Natchez was named chairman of a steering committee to assist the Delta Section in handling the Petroleum Branch Annual Meeting to be held in New Orleans in 1950. ★ ★ ★

W. D. Owsley, who spoke on the Hydrafrac process at the May 18 meeting. A native of Chickasha, Okla., he attended Georgia School of Technology and Oklahoma Univ., where he graduated in P.E. in 1931. He joined Halliburton then and has served as division engineer for the Gulf Coast and California, designing engineer, mechanical research supervisor, and chief engineer. Since 1947 he has been technical adviser for the Halliburton organization.

Kansas Section Activities

By Carl Lund

Monthly Meeting

On May 3 the Section held its monthly meeting at the Crescent Club in Ellinwood, Kansas. W. R. Warren, with Stanolind Oil & Gas Co. in Ellinwood, arranged the fellowship hour, dinner and program, which was attended by 42 members and 18 visitors.

Featured speaker of the meeting was Neill Ferrill, who talked on "Economic Factors Involved in Work-over Operations and Equipment Replacement," a timely subject of much interest to Kansas engineers. He discussed how to evaluate and appraise the economic level of a partially depleted well and how to determine the useful life of present well equipment. He presented three types of printed forms which secure all of the necessary information for expediting the petroleum engineers' work-over proposal.

Following Ferrill's talk, Art Rhodes of the Phillips Pet. Co. in Great Bend, Kansas, gave a prepared discussion of the paper. Rhodes expressed his agreement with Ferrill in his pointing out the advisability of a more detailed report for the field engineer. This discussion led into an open discussion in which several engineers representing a major company discussed their company policies and procedures in work-over operations. After the discussion Chairman V. J. Mercier appointed a committee of W. R. Warren, William Pugh, H. R. Roberson and W. R. Goodier to study the possibility of a field trip and picnic in western Kansas during July.

Lecture Series

Morris Muskat of Gulf Research and Development Co. presented his series of lectures on reservoir engineering at the Univ. of Kansas on May 6, 7 and 8. Approximately 125 petroleum engineers from Kansas, Oklahoma and Texas registered for the series, which included the following lectures: "Relative Permeability", "Condensate Reservoirs", "Gas Drive Performance", "Gas Injection", "Water Injection Well Histories in Water Flooding" and "Partial Water Drives". The series was sponsored jointly by the Univ. of Kansas and the Kansas Local Section, and no registration was charged.

The men responsible for the planning and arrangements of the water flood secondary recovery field trip of the Kansas Section of May 19. Left to right they are: Fred Kluck, Ohio Oil Co.; Ward A. McGinnis, host for barbecue; Edward A. Arnold, Phillips Pet. Co.; Paul Witherspoon, trip chairman, Phillips Pet. Co.; V. J. Mercier, Lane Wells Co.; Hubert Walker, Magnolia Pet. Co., and Wendell Haugh, Tidewater Associated Oil Co.

Over 100 of the visiting engineers attended a banquet on the evening of May 6 in the campus union building for which Dolph Simmons, publisher of the Lawrence Journal World was the banquet speaker. He had just returned from a round-the-world tour, and his speech was a review of his trip.

Field Trip

Two hundred and fifty engineers and operators visited the water floods of Greenwood County, Kansas on May 19, in a field trip sponsored by the Section and the Kansas-Oklahoma Water Flood Operators. Prior to the field trip, a meeting was held in Eureka, Kansas, under the leadership of P. A. Witherspoon, chairman of the field trip committee. General geological and historical features of the oil fields located in the Greenwood County Area were discussed at the meeting. The group visited the Burkett Unit water flood project operated by Phillips Pet. Co. and the Seeley Unit project, operated by Magnolia Pet. Co. Visits to the Clopton Unit operated by Cities Service Oil Co. and the York DeMalorie Lease, which was the first legal water flood in the state of Kansas and is currently operated by Phillips Pet. Co., were prevented by inclement weather. At the conclusion of the field trip, Ward A. McGinnis entertained the group with a barbecue dinner at his ranch near Eureka.

In the general meeting prior to the field trip, a number of interesting points were discussed with regard to the so-called "Bartlesville" shoestring sands of Greenwood County, Kansas. The most comprehensive geological report on this subject was written by N. Wood Bass and published on September 15, 1936, as Bulletin 23 of the State Geological Survey of Kansas. Bass concluded that the "Bartlesville" shoestring sands were originally deposited as off-shore bars in a shallow sea during the early Pennsylvanian period. The first oil production in the County was found in the Mississippi lime in the Virgil pool in 1916, and in 1917 additional Mississippi lime wells were drilled in the Beaumont and Eureka pools. Subsequent drilling revealed the presence of a lime "high" called the Beaumont Anticline, which extends

TABLE I

Water Floods in Greenwood County, Kansas, as of May 19, 1949

No.	Pool	Developed Acres	Operator
1.	Atyeo	60	Barbara
2.	Atyeo	128	Ohio
3.	Blankenship	97	Great Southern
4.	Blankenship	28	Sohio
5.	Burkett	665	Phillips
6.	DeMalorie Sowders		Mid-Continent
7.	DeMalorie Sowders	70	Phillips
8.	Fankhouser	5	Harrigan Bros.
9.	Fankhouser	75	Sunray
10.	Fankhouser	60	Phillips
11.	Hamilton	128	Cities Service
12.	Lamont		Cities Service
13.	Pixlee	187	Barbara
14.	Sallyards	168	Ohio
15.	Scott	120	Phillips
16.	Seeley-Wick	178	Cities Service
17.	Seeley-Wick	5	Cities Service
18.	Seeley-Wick	285	Phillips
19.	Seeley-Wick	541	Magnolia
20.	Seeley-Wick	167	Phillips
21.	Seeley-Wick	80	Phillips
22.	Seeley-Wick		Skelly
23.	Teeter	73	Ohio
24.	Teeter	200	Cities Service
25.	Thrall-Aagard	47	Phillips
26.	Thrall-Aagard	8	Phillips
27.	Thrall-Aagard	110	Phillips
28.	Thrall-Aagard	80	Phillips
29.	Thrall-Aagard		Ark. Fuel
30.	Thrall-Aagard	41	Ohio
31.	Thrall-Aagard	91	Ohio
32.	Thrall-Aagard		Sinclair-Prairie
33.	Madison	115	Cities Service
34.	Polhamus	40	Glen Smith
35.	Palhamus		Sohio
36.	Batesville		Sheedy

from the Beaumont through the Reece, Eureka, Virgil, Virgil North and Dunaway pools. The first shoestring sand pool was opened up in 1917 with a well drilled in the Sallyards field. In 1921, the Teeter Pool was opened up and the Browning, Burkett, and Seeley Pools were discovered in 1922. In 1923, the discovery of the Aagard pool started the most active drilling campaign in the state of Kansas. Discoveries of the various other shoestring sands continued on through the 1920's.

Gas repressuring was started as early as 1935, and some of the most successful repressuring operations were conducted in the Browning, DeMalorie Sowders, Madison, Teeter and Thrall pools. The first legal water flood in the state of Kansas was started by the York State Oil Co. in May 1935, on their DeMalorie Lease. The second water flood was started by Phillips Pet. Co. in 1937. In the early 1940's several more floods were started, and as the success of these projects became known, the development of additional floods steadily increased. A list of the projects in operation as of May 19, 1949, is given on Table I. In all, there are 29 water floods in Greenwood County with approximately 4,000 developed acres. This represents about 25% of the total floodable acreage and, therefore, there are some 16,000 potentially floodable acres in this area. If an ultimate recovery of 3,000 barrels per developed acre is assigned, the total water flood recovery to be obtained in Greenwood County amounts to 50,000,000 barrels of oil. This figure should be taken as an indication of the magnitude of the potential secondary recovery in Green-

(Continued on Page 17)

TABLE II

Water Flood Data and Results

Item	Burkett Unit	Clopton Unit	Seeley Unit	York DeMalorie and Oneal Leases
1. Date of initial injection	Aug. 1942	Feb. 1946	Jan. 1943	May 1935
2. Acres developed to date	665	178	541	285
3. Average sand depth, ft.	2080	1900	1975	1950*
4. Average sand thickness, ft.	38	35	30-33	47*
5. Average porosity, %	15.6	18.4	18	17†
6. Average permeability, md	7.5	19.7	27	24†
7. Input wells	74	21	60	27
8. Producing wells	89	25	61	35
9. Current oil production, BPD	1225	374	2688	870
10. Current water production, BPD	7048	2417	7047	3168
11. Current water input, BPD	9124	4129	11,140	4470
12. Primary recovery (1-1-49) Bbls/acre	4600	4870	6600	5780
13. Secondary recovery (1-1-49) Bbls/acre	4930	2180	3430	3850

Note: * Based principally on cable-tool logs
† Average results from six cored wells

Everyone was well occupied during the barbecue at the McGinnis ranch.

Pacific Petroleum Chapter Activities

By Frank Parker

April Meeting

Clark L. Thomas spoke before the Technology Forum April 25 on the studies made by E. G. Bemis and himself of development and production in the Tar Zone of Huntington Beach Field, Southern Calif.

The Tar Zone production is found in the Town Lot Area in the southwest portion of the field. The Tar Zone was discovered in the early "twenties" and had a rapid period of development during which 57 wells were drilled. After a long dormant period another burst of drilling activity started in 1947 with 150 wells drilled to the present time.

Ray Hancock, Lane-Wells Co. in Los Angeles, is Exhibits Chairman for the Fall Meeting in Los Angeles. He reports a brisk demand for booths from supply and service companies.

The early wells were completed with coarse slotted liners and were plagued with sand trouble, collapsed liners and the usual troubles attending production of heavy oil from free flowing sands. Declines averaged 60% or more the first year from initial production of 100 to 300 B/D. In the early period some 3,500,000 bbl. were produced amounting to 61,000 bbl. per well and 170 B/ac.ft. One 12-acre parcel with 20 wells produced over 1,000,000 bbl. amounting to 620 B/ac.ft., though here some favorable drainage may have been accomplished.

In 1947 with price increase of heavy crude oil and advances in the completion and production techniques, the Tar Zone again appeared favorable to operators. In this later development control of sand has been attempted by use of pre-pack or flow-pack gravel screens, although there has been some use of slotted liners also. The flow-pack has shown much better results than pre-pack, particularly in decline rate. Sand entry has been practically eliminated by both gravel pack methods, although plugging of the gravel by fine sand has been common. To a large degree the rapid decline is due to plugging of the slots or gravel pack with both sand and tarry material. A fair mechanical success has been met with in hot crude oil washes of slotted liners, although the net economics of this procedure are not strikingly favorable. A lighter gravity crude from other zones in the field is most satisfactory and economical. The prepared commercial washing materials have not been successful as compared to the crude oil washing. Gravel pre-packs do not respond to wash treatment and none have been attempted on flow-packs. So far as liners are concerned, in summary, the slotted liner of 30 to 50 mesh and the flow-pack are the more successful, the slotted liner because of ease of installation, response to washing and ease of repair, and the flow-pack because of initial and sustained rates of production.

Gravel packs have been installed in

Clark L. Thomas, speaker for the April 25 Forum meeting. He is a native of Canada and a graduate of Colorado School of Mines in '41; was in the Army Air Forces during the war and has since been a petroleum engineer in development work with Standard Oil Co. of Calif.

E. G. Bemis, his associate in this work, is a native of Seattle and a graduate of the U. S. Naval Academy in '35. Except for the war period, when he served in the U. S. Navy, and a year in consulting work, Bemis has been a petroleum engineer for Standard Oil of Calif.

Two views of the April 25 Meeting of the Technology Forum.

multiple completions by use of stage cementing and drillable sections. This method has been successful in areas where there is intermediate water between the upper and lower sands of the Tar Zone.

The presentation was followed by a lively period of discussion in which E. G. Bemis was called upon to expand upon some of the points mentioned above.

May Meeting

The Carneros pool of the Salt Creek Field in Calif. was the subject presented by Gordon Wells and Robert Mangold of the Independent Exploration Co. at the May 23 meeting of the Technology Forum.

The Salt Creek Field is about 45 miles west of Bakersfield, Calif., at the east margin of the Temblor range. It was discovered in 1946 by the Independent Exploration Co., and since that time 63 wells have been drilled proving up 280 acres. The oil is found in the Carneros sand of Miocene age at depths of about 3000 feet. The field is divided into four fault blocks which essentially form four separate pools in the Carneros sand. The accumulation of oil is controlled by faulting in the west and a pinch-out line to the southwest, the structure being primarily a nose plunging eastward. There is about 800 feet of structural relief above the edgewater limits to the north and east. The structure in the Miocene rocks is not reflected in the overlying Upper Pliocene and Pleistocene.

There is no evidence of a primary gas cap in three of the fault blocks, although somewhat higher G.O.R.'s were reported at the highest structural position. In the fourth fault block only dry gas of 0.6 gravity is found with no evidence of an oil band. This occurrence of dry gas is anomalous in that it occurs at a structural position about equivalent to the center of the oil column in the other blocks. However, the gas produced with the oil in the other blocks is of approximately the same composition.

The reservoir is a clean sand with a maximum thickness of 220 feet and an average thickness of 150 feet. Very few cores have been taken but the indicated porosity is approximately 33%, the air permeability about 1800 md. and connate water 22%. The original bottom hole pressure was 1230 p.s.i. and the original G.O.R. range from 90 to 150 cu. ft./bbl. The initial specific productivity index approximated 0.2 B/ft./lb. drawdown.

The field was drilled up rather rapidly under competitive conditions and reached the maximum production of 7000 B/D late in 1947. By that time the pressure had declined to 635 p.s.i. and the G.O.R. had reached nearly 1000 cu. ft./bbl. Some influx of water was noted in edge wells, and at the end of 1947 amounted to about 5% cut for the field. A considerable pressure variation and unbalance had been reached at that time. These conditions led to the decision to unitize the operation and to attempt gas injection. There was a period of curtailed production and conservation practice between this time and the start of gas injection in October of 1948. High G.O.R. wells and high water cut wells were closed in thus improving the gas oil ratios and reducing the production rate to 4500 B/D. Shutting in of the high G.O.R. wells in some cases resulted in increasing the G.O.R. of neighboring wells. Tests of the shut-in wells after approximately a year showed no improvement in their G.O.R. In some cases it was higher.

Injection has been confined to three wells on the high of the structure, and there has been some evidence of by-passing of gas to nearby wells. Where nearby wells have shown an increased production with no serious increase in G.O.R., they have been produced—but in other cases of by-passing the wells are closed in. The gas is injected at 850 to 1050 p.s.i. and it was at first planned to use the dry gas of block No. 4 for this purpose. However, there was a rather rapid decline in the pressure in block No. 4, and it is now planned to use the gas produced with the oil in one of the other blocks for injection. The gas is injected at the rate of about 2600 Mcf/D and to date about 350,000 Mcf has been injected. The production to date has amounted to about 125 B/ac/ft. out of calculated original volume of 1800 B/ac/ft. of oil in place. No estimate of the prospective ultimate recovery was offered. It was felt, however, that with the improvement in pressure balance throughout the field, the reduction in overall G.O.R. and the balancing of withdrawal and

(Continued on Page 17)

Robert Mangold spoke on the history and engineering practices of the Salt Creek field for the May meeting. He was born in St. Louis, Mo., and attended Washington Univ. there, later graduating at the U. S. C. in 1930. He has been a petroleum engineer with the U. S. Geological Survey, the Shell Oil Co., and the Independent Exploration Co.

Gordon Wells spoke on the geology and general character of the Salt Creek field for the May 23 Meeting. A native of Park City, Utah, and a graduate of New Mexico School of Mines in 1931, he worked for Pacific Western Oil Co. and the Getty companies until 1943 when he joined the Independent Exploration Co. in Bakersfield.

Gulf Coast Section Activities

By J. E. Kastrop

An enthusiastic group of nearly 100 members and guests attended the Gulf Coast Section's May 17 meeting held at the Houston YMCA. Chairman Owen Thornton asked for committee reports and regretfully announced the resignation of the Section's efficient secretary-treasurer, E. F. Stratton, Schlumberger Well Surveying Corp., who was recently appointed manager of the company's Rocky Mountain area with headquarters at Denver, Colorado. The Section's Board of Directors, following provisions for filling such vacancies in the Petroleum Branch, elected A. G. Gueymard, assistant to the vice-president, oil and gas division, City National Bank, Houston. Gueymard was formerly division petroleum engineer for Tide Water Associated Oil Co. in Mississippi and Louisiana.

In presenting the question of an increase in membership dues, the chairman reported that the Section's board of directors had discussed the problem and had appointed a committee for the specific purpose of making a thorough investigation of the financial status of the Institute and reporting their findings and recommendations to the membership. This committee, headed by Stuart Buckley, Humble Oil & Ref. Co., consisted of George L. Nye, City National Bank, I. W. Alcorn, The Pure Oil Co., and Fred Nelson, Texas Gulf-Sulphur Co. Buckley gave a careful analysis of the situation as it has appeared over the past several years, summing up his findings, that, based on the increased service to the individual Institute member as a result of recent changes in organizational structure and policy, together with greater efficiency in management and bookkeeping, the committee conscientiously recommended the approval of a temporary dues increase as proposed.

Two representatives of the Irving P. Krick Co., consulting meteorologists, Pasadena, Calif., discussed the subject of "The Field of Industrial Meteorology and Its Application to the Petroleum Industry". Loren W. Crow, technical representative from the company's Pasadena headquarters, spoke on the industrial applications of long-range weather predictions as they apply to business activity and operations. Fields of application for weather forecasting are numerous and include military, petroleum, agriculture, construction, transportation, shipping, power and fuel utilities, and many other businesses affected by outdoor activity. By knowing future temperatures, gas companies can better prepare for peak fuel loads, and pipe line companies can, in advance of heavy gas demand, step up pressures and volumes of natural gas pumped through large transmission lines. Hydro-electric companies can plan on water levels to be expected in reservoirs, and are better able to determine when to convert to coal for steam generation.

Norman J. MacDonald, liaison executive for the company's Houston office, spoke on the application of meteorology to the oil industry. He gave one illustration to point out the value of weather forecasting for land operations, citing a case where the operator had to decide whether to remain in one particular area or move to another area. Weather predictions showed that heavy rains were expected in the second area, making it advisable to remain in the first area. Such forecasting can, in some cases, be used to estimate when water would be available in arid areas, thereby aiding the drilling operations considerably.

Long-range weather forecasting is of paramount importance in offshore operations in the Gulf of Mexico. Winds, squalls, wave heights, tides, and operational limits can be predicted in advance of the drilling program. In geophysical work, weather forecasting has been valuable in selecting the periods of operation as well as in determining the types of boats and instruments to be used. The speaker presented several cases where estimates of the possibilities of waves breaking at various heights in the Gulf throughout the year were made. Of extreme value to the offshore operator is advance knowledge of hurricanes so that he may shut down drilling operations and move floating equipment and personnel to safety.

Personals

J. J. CROWDEN, recently associated with the Quintana Pet. Co., has transferred his membership from the Delta Section, New Orleans, to the Gulf Coast Section.

E. L. PETREE, program chairman for the Gulf Coast Section, was recently made assistant superintendent of production, Gulf Oil Corp., at Houston. He was formerly chief petroleum engineer, taking this position in January, 1948. ★ ★ ★

Everett F. Stratton, left, Schlumberger Well Surveying Corp., Houston, former secretary-treasurer for the Gulf Coast Section has been promoted to manager of the company's Rocky Mountain area and will move to new headquarters in Denver, Colorado. Elected to take his place is A. G. Gueymard, assistant to the vice-president, oil and gas division, City National Bank, Houston.

Chairman Owen Thornton, center, welcomes the speakers of the May 17 meeting. At left is Loren W. Crow, technical representative, and at right is Norman J. MacDonald, liaison executive. Both men are with the Irving P. Krick Co., consulting meteorologists.

East Texas Section Activities

By P. E. Des Jardins

The May meeting of the East Texas Section was held at the Kilgore Hotel on May 10. A slight lag in attendance was noted since some members were attending the Railroad Commission's M.E.R. hearings at Austin. In a discussion about when to hold the summer recess it was decided to hold the next regular meeting of the Section in September rather than June. Therefore, the Section will not hold any meetings in June, July, or August.

R. M. Hess, chairman of a committee appointed to investigate the proposed dues increase, made a report of his committee's findings and a lively discussion ensued. W. W. Leonard thanked the committee in behalf of the Section.

The meeting was highlighted by a talk on "Sucker Rod Pumping as a Complete System", presented by J. C. Slonneger, consulting engineer with the Continental Supply Co., Dallas. Slonneger stressed the fact that the resilience of the sucker rods together with the resulting stored energy in the rods imposes a difficult problem in transmitting the power from the prime mover to the pump in the well. The most significant effect is that produced by the natural vibration of the rods. The effect of this vibration upon the configuration of dynamometer graphs was discussed from the theoretical point of view, and practical example was shown by slides.

The speaker further demonstrated that dynamometer graphs may be analyzed to determine the event which occurs at the plunger. He argued that the sucker rods should be designed to suit the pumping requirements and that the stroke per minute should be chosen to avoid excessive rod vibration.

To do the best possible job of pumping, each element, that is the pump, the rods, the pumping unit, the V-belt drive, and the engine, should be considered as a part of a complete system and chosen to fit neatly into the system.

Prime movers should be provided with a large amount of inertia in their rotating system to insure steady operation against the rapid fluctuation of the load imposed by the resilience of the rod system.

Prime movers, of course, should require a minimum of attention and shutdown for service and repair. The development of the single cylinder vapor-cooled engine with large inertia, according to the author, was a step in the right direction. He stressed the importance of good operation, especially care in adjusting the counter balance to its best value.

Slonneger stated that he had never come in contact with a pumping system perfect in every respect; hence, there is much to be done in this field.

J. C. Slonneger, speaker for the May 10 meeting, who is a native of Illinois. After graduation from the Univ. of Illinois he spent about 20 years in the Mid-West in the manufacture of farm machinery and transmission equipment, in both engineering and management. He has been engaged in oil field equipment work since 1935, and is at present a consulting engineer with the Continental Supply Co. in Dallas.

Personals

J. A. Williams, Jr., has recently assumed the duties of petroleum engineer at Texas Co.'s office at Gladewater, Texas.

W. G. Abbott, formerly field engineer with Amerada Pet. Corp. at Longview, has been transferred to Amerada's Midland office. Herbert D. Miller has replaced Abbott as field engineer in Longview.

Paul Kinsvater, whose former duties with the engineering department of British-American Oil Co. in Houston frequently brought him to East Texas, has now been promoted to field superintendent with headquarters in Kilgore. ★

A view of the group attending the May 10 meeting.

Delta Section Activities

By J. Paul Ratliff, Jr.

On May 3 the Delta Section held its final dinner meeting of the spring season. Russell B. Brown, counsel of I.P.A.A. of Washington, D. C., talked informally on the views and opinions at the Capitol of the technical man's contributions to understanding in industrial matters. It was apparent from the number of questions asked Brown and the great interest shown in his remarks that the members of Delta Section were quite pleased to get an inside slant on petroleum news in Washington.

E. N. Van Duzee conducted the annual LSU student paper contest. With an excellent paper entitled *Secondary Recovery*, Marsden J. Dupuy was voted winner of the student paper competition. *What Students Expect of Industry* by M. F. Manville, and *Potentiometric Model Studies* by Robert K. Byrne were also presented and received very favorable comment. The high standard of the student papers led to many compliments for Prof. Benjamin C. Craft of Louisiana State Univ.

A directors' meeting was held by the Delta Section on May 12 at the Vieux Carre Restaurant. Fifteen members were present to review the status of the section with John R. Suman, vice-president of the Standard Oil Co. of New Jersey, and a director of AIME. Suman covered many points of interest and invited members of the Delta Section to attend the AIME's directors' meetings in New York whenever possible.

The Delta Section will sponsor a field trip on June 8 to the mining operations of the Freeport Sulphur Co. at Grand Ecaille.

Personals

LESTER B. SWAN, Dowell Inc. district manager at New Orleans, La., has been named general manager of United Oilwell Service, S. A., in Caracas, Venezuela. United Oilwell Service is an associate company of Dowell.

CHARLES L. POWER, JR., district development enginer in Lafayette, La., has been named Dowell district manager in New Orleans to replace Swan. ★ ★ ★

Southwest Texas Section Activities

By Raymond Keller, Jr.

The first meeting of the Section for this year out of Corpus Christi was held May 13 at the Plaza Hotel in San Antonio. Over 130 members and guests attended from points as far away as Brownsville. Lloyd Elkins, chairman of the Petroleum Branch attended the meeting and commended members of the section for the activity, and particularly for the long drives they take to attend meetings.

Harry H. Power, head of the petroleum engineering school of Univ. of Texas, George H. Fancher, professor of petroleum engineering there, and 17 senior students were among the guests attending.

R. H. McLemore of Welex Jet Services, Inc., in Fort Worth, was principal speaker for the meeting with his presentation of *The Jet Process of Perforating Oil Well Casing*. The paper was reviewed in the East Texas Section Activities in the February JOURNAL.

The June meeting for the Section was a barbecue at Humble Oil & Ref. Co. Stratton Camp on the King Ranch, June 4. ★ ★ ★

Mid-Continent Section Activities

By Jack H. Beesley

A. F. van Everdingen spoke to 100 members and guests of the Mid-Continent Section on "Practical Application of Water Influx Computations" on May 31, at Lorton Hall, Univ. of Tulsa.

Van Everdingen showed how the La Place Transformation could be applied to flow problems in reservoirs to simplify and speed up material balance calculations. This discussion was augmented by a comparison of calculations with production histories of various reservoirs.

Section officers for 1949-50 were installed. Presiding were H. M. Cooley, the new chairman, and J. J. Arps, Study Group Chairman.

This was the last Section meeting until September.

A. F. van Everdingen, right, regional reservoir engineer with Shell Oil Co. in Houston. A native of Holland, he is the author of several significant technical papers published by the AIME.

Junior Group Activities
Pacific Petroleum Chapter

Ian Campbell, professor of petrology at California Institute of Technology gave an informative talk before the Junior Group on May 18 under the subject of "Rocks Under the Microscope." The talk covered, in basic terms, the methods used by the petrologist to determine the mineral composition of rocks, the geologic conditions leading to their formation, the age of rocks by measurement of the decomposition of included radioactive minerals, and the crystal lattices of the various minerals. Slides and projections of thin rock sections were used to illustrate the talk. By using polaroid and gypsum filters on the thin section projector, Campbell showed how the projection of a section of common rock could be transformed into a pattern of brilliant colors for each of study.

Forty-five members and guests attended the meeting. ★ ★ ★

Charles T. McClure, left, Group chairman, and Harold Nissen, right, Group membership chairman, welcome Ian Campbell, speaker for the May 18 meeting. Campbell attended the University of Oregon and Northwestern Nniv., and completed his graduate work at Harvard Univ. He is now professor of petrology at California Institute of Technology. He is past Western vice chairman of the Industrial Metals Division of AIME, and present chairman of the Southern Section of that Division.

Kansas Section

(Continued from Page 11)

wood County. This volume of oil is approximately ⅕ of the water flood oil recovery that has been obtained in the Bradford field of Pennsylvania.

A summary of important data on each of the water flood projects that were included in the field trip is shown on Table II. Ten-acre spacing is used on each of these projects with the input wells drilled on a 5-spot pattern. The Burkett, Clopton, and Seeley units use a closed water injection system, and the York DeMalorie and O'Neal leases use an open system with lime treatment and filtration. The Clopton, Seeley, and York DeMalorie floods are pumped with individual units, and the Burkett Unit is pumped by central geared powers. In pointing out the benefits of unitization, it was mentioned that the Burkett Unit originally consisted of 19 separate leases. It is now operated as one lease and has only 6 tank batteries. The Burkett, Clopton, and Seeley units are currently injecting water with surface pressures varying from 400 to 600 psi. Water injection on the York DeMalorie and O'Neal leases is primarily by gravity flow although part of the project is operating with about 150 psi surface pressure. ★ ★ ★

Pacific Chapter

(Continued from Page 13)

imput, that not only would the flowing life of the wells be prolonged but the ultimate recovery would be improved.

There has been no plans for water injection as a means of promoting recovery since it was learned that serious sand troubles are attendant on production showing a high water cut, and it appears that depletion and gravitation drainage will be responsible for the ultimate production.

June Forum Meeting

On June 27, Russell Wade of Union Oil Co. will discuss the reservoir performance of the Seventh Zone, Town Lot Pool of the Dominguez Field. This is a depleted pool so the entire history can be told—a rather unusual situation for a modern pool for which considerable engineering data has been available from the discovery.

No meetings of the Technology Forum are planned for July and August.

Personals

RICHARD H. SMITH, formerly reservoir engineer for Signal Oil & Gas Co., has been made general production superintendent of the company. He replaces E. L. DAVIS, who has left the company to manage field operations at Point Barrow for the Arctic Exploration Co. ★ ★ ★

Professional Services

This space available only to AIME members. Rates upon request.

AMSTUTZ AND YATES, INC.
Consulting Petroleum Engineers
Valuations
Reservoir Analyses
Geologic Investigations
406 KFH BLDG., WICHITA 2, KANSAS

CARLTON BEAL
Consulting Petroleum Engineer
11699 BELLAGIO ROAD
LOS ANGELES 24, CALIFORNIA
Phone: ARizona 74294

FRANK N. BOSCO
PETROLEUM ENGINEERING
Exploration — Evaluation — Operation
838 Symes Building — *By Appointment Only*
PHONE: TABOR 7361 — DENVER, COLO.

PAUL CHARRIN
Consulting Engineer
ATLAS WELL SERVICE CORPORATION
UNIVERSAL EXPLORATION COMPANY
913 Union National Bank Building
HOUSTON 2, TEXAS
Phone: Preston 0060

ALEXANDER M. CROWELL
Natural Gas Consultant
So. Arkansas — LOUISIANA — Coastal Texas
NEW ORLEANS — SHREVEPORT
1415 Carondelet Bldg. — 3746 Richmond Ave.
Phone: Raymond 3861 — Phone: 8-1419

CRUTCHFIELD AND PRUETT
CONSULTING PETROLEUM ENGINEERS
224 Wilson Building
CORPUS CHRISTI, TEXAS
John W. Crutchfield — *Horton T. Pruett*

ALEXANDER DEUSSEN
Consulting Geologist and Petroleum Engineer
Room 413, Commerce Bldg. Addition
HOUSTON 2, TEXAS

EARLOUGHER ENGINEERING
Petroleum Consultants - Core Analyses
Specializing in Secondary Recovery
Investigations - Appraisals - Operations
311-319 East Fourth Street
TULSA 3, OKLAHOMA
Office 2-5129 — Laboratory 2-6139

FARIS & WARREN
Consulting Petroleum Engineers
McClintic Building
MIDLAND, TEXAS
Production & Reservoir Engineering
Evaluations — Development

FITTING, FITTING & JONES
Engineering & Geological Consultants
Petroleum — Natural Gas
Box 1299
PERMIAN BLDG. — MIDLAND, TEXAS

WILLIAM HURST
Petroleum Consultant
Reservoir Engineering - Primary & Secondary Recovery, Gas Cycling Evaluations
BERMAC BUILDING — 4101 SAN JACINTO
Hadley 0935 — Madison 2-1181
HOUSTON, TEXAS

MICHEL T. HALBOUTY
CONSULTING GEOLOGIST
AND PETROLEUM ENGINEER
Shell Building
Houston 2, Texas — Phone P-6376

H. L. KIRKPATRICK
CONSULTING PETROLEUM ENGINEER
Property Management - Well Completions
Proration - Reports - Appraisals
445 Delaware Avenue
SHREVEPORT, LA. — PHONE 7-8295

GEORGE Y. McCOY
Petroleum Consultant
Reserves Estimates and Valuations
Empire Bank Building
DALLAS 1, TEXAS

ERNEST K. PARKS
CONSULTING PETROLEUM ENGINEER
Planning, Direction and Examination of Oilfield Operations, Estimates of Oil and Gas Reserves, Oil Property Valuation
614 S. HOPE STREET, LOS ANGELES, CALIF.
Telephone: VanDyke 4659

HARRY H. POWER
Consulting Petroleum and Chemical Engineer
P. O. Box 1542 — University Station
AUSTIN, TEXAS
Phone: 2-1954

A. L. SELIG
Consulting Petroleum Geologist
GULF BUILDING — HOUSTON, TEXAS

S. FRED SHAW
Gas Lift Specialist
301 Terrell Road, Phone: T-9754
SAN ANTONIO, TEXAS

WM. H. SPICE, JR.
Consulting Geologist
2101-03 Alamo National Building
SAN ANTONIO 5, TEXAS

HARRY C. SPOOR, JR.
Consulting Geologist
Petroleum . . . — . . . Natural Gas
COMMERCE BLDG. — HOUSTON, TEXAS

JOHN G. CAMPBELL, CHEMIST
Field Charcoal & Padbielniak Analyses
Waters — Oil Field Brines — Cores
422 N. Lower Broadway, Corpus Christi, Texas

JOSEPH B. UMPLEBY
Geologist and Engineer
Office Consultation Only
5945 LUTHER LANE
DALLAS 5, TEXAS

HAROLD VANCE
CONSULTING PETROLEUM ENGINEER
Pet. Engr. Dept. — A & M College
College Station, Texas

BASIL B. ZAVOICO
Petroleum Geologist and Engineer
220 E. 42nd St. — City National Bank Bldg.
New York 17, N. Y. — Houston, Texas
MUrray Hill 7-7591 — Charter 4-6923

Technical Notes

This department was conceived as a place for the expression of your ideas. It can present theories or reports on current or possible technical practices or concepts that are not adaptable to full technical paper treatment. Or, it is a place where you may present ideas without writing a full technical paper. Within space limitations, the material you present for publication here will be printed in full, and without the close scrutiny given to full technical papers.

When men are engaged in an activity as complex as petroleum engineering, there is bound to be a wide variation of thought on methods, practices and concepts. This department is where the variations should appear. A brisk difference of opinion is a sign of a healthy and aggressive profession; it will stimulate interest and produce a worthwhile exchange of ideas.

So we invite you to use this department freely for the betterment of the petroleum engineering profession.

The Editor

Student Activities

University of Oklahoma

The Petroleum Engineers Club of the University of Oklahoma, a student chapter of the AIME which has been on the campus for 25 years, has been very active during the semester just ended.

Under the leadership of Don Powell, president, the club had a number of prominent speakers, a few of which were G. M. Stearns of Stanolind Oil & Gas Co. in Tulsa, Claude Barrow, Oil Editor of THE DAILY OKLAHOMAN, C. E. Reistle of Humble Oil & Refining Co. in Houston, W. H. Stueve of Oklahoma Gas & Electric Co., and Wesley W. Moore of British American Oil Co. in Oklahoma City.

In addition to the meetings held for these speakers, the Petroleum Engineers Club sponsors the annual spring Petroleum Engineering Open House Exhibit. This year it was held in conjunction with the joint meeting of the Oklahoma City and Mid Continent Local Sections held on the University of Oklahoma campus on April 27.

Professor Wilbur F. Cloud of the Petroleum Engineering School is faculty sponsor. Other officers are: T. G. Ward, vice president, Clifford Banks, secretary-treasurer, Morris Todd, publicity director, Preston Rennie, entertainment, and Spencer Taylor, openhouse chairman. The club is inactive during the summer months.

Pi Epsilon Tau, honorary petroleum engineering fraternity on the campus, has also been active during the past semester. Primary activity was a field trip to oil field manufacturing and service industries, which was attended by six faculty members and 40 students. Professor N. Van Wingen has been faculty sponsor, with Charles R. Olson, Jim Murdoch, Morris Todd and Willard Brill holding the key officerships.

University of Wichita

One of the newest Affiliated Student Societies of the AIME was organized February 2, 1949, at the University of Wichita in Wichita, Kansas, under the name of the Geology Club. Officers were elected at the first meeting and served during the semester just passed. They are: Robert Watchous, president; Elbie McNeil, vice president; Claud Sheats, secretary, and Douglas McGinness, treasurer. Professor J. R. Berg was chosen as the club's faculty sponsor, and E. A. Koester was named practicing counselor. A charter was granted from the AIME on March 3.

Jack Magathan and Gerald Ramsey, program chairmen, obtained several prominent speakers from the petroleum industry during the semester. The club also attended two field trips, one conducted jointly by the Kansas and Oklahoma Sections of the AIME, and one under sponsorship of the Kansas Geological Society. Also, a post-final stag was held in honor of the graduating seniors. ★ ★ ★

Employment Notices

The JOURNAL will post notices of men and jobs available. Companies and AIME members are invited to use this space, for which there is no charge. Except as noted below, address replies to: Code (appropriate number), JOURNAL OF PETROLEUM TECHNOLOGY, 601 Continental Bldg., Dallas 1. When applying for a position, give complete qualifications in first letter, and show return address on envelope. These replies will be forwarded *unopened*, and no fees are involved. Any answer will come directly from the firm listing the job.

Replies to positions below which are coded Y2198 and Y2378 should be addressed to: Engineering Societies Personnel Service, 8 West 40th St., New York 18, N. Y. The ESPS, on whose behalf these notices are published here, collects a fee from applicants actually placed.

PERSONNEL

♦ Petroleum Engineer, M.S. in oil geology and production. Young, veteran of Polish forces in Britain unable to return to Poland. Desires position with oil company in field or in research work. Four years' practical experience in field, one year postgraduate studies. Married, but prepared to declare single status one year. Will go anywhere, do anything in drilling, production or geology. Code 104.

♦ Graduate Mechanical Engineer desires position with good opportunity for advancement with oil company or associated industry. Presently employed as petroleum engineer by major oil company. Married; age 25. Code 105.

POSITIONS

♦ Petroleum Engineer with at least 10 years' varied field experience, knowledge of exploratory problems, administrative experience and the ability to plan large-sized operations. Permanent. Location, Turkey. Code Y2198.

♦ Assistant professor to take charge of a newly-created curriculum in petroleum production engineering in a southeastern university. Salary $3,900 for 9 months. Possibility of $900 more for summer work in research. State personal data, education and experience. Y2378.

♦ Reservoir Engineer—for New York office. Requires several years' experience in reserve estimation, material balance and maintenance, water flooding, well spacing, etc. Salary to be commensurate with experience and ability within the range of $7,200 to $9,600 per year. Code 501.

♦ Senior Petroleum Engineer — for Venezuela. To administer and coordinate petroleum engineering activities in a field division. Approximately ten years' experience. Working knowledge of Spanish required. Experience in Latin American oil fields and single status preferred. Salary according to experience, $600-$700 per month base, plus living allowance and yearly bonus. Code 508.

♦ Equipment Engineer—for Venezuela. Several years' experience in drilling and production equipment necessary. Salary according to experience, $6,300-$7,800 per year base, plus living allowance and yearly bonus. Code 503.

♦ Reservoir Engineer—Colombia, field. Five-ten years' experience in reservoir engineering with familiarity of reserve estimation, well location and spacing, producing rates, etc. Base salary $400-$600. Age limit 40. Code 504.

♦ Petroleum Engineer—Colombia, field. Three-eight years' field experience in drilling and well completion, mud control, cementing, production, etc. Base salary $400-$500. Age limit 40. Code 505.

Announcement of Staff Positions
Petroleum Engineering Department
University of Oklahoma

The following are permanent staff appointments. Salaries will depend upon training and experience.

(1) Professor of Petroleum Engineering—Advanced degree in petroleum engineering or a fundamental science preferred. Experience in reservoir work, evaluation, or research problems. Undergraduate and graduate instruction and supervision of graduate students. Nine months. Appointment Sept. 1.

(2) Associate or Assistant Professor of Petroleum Engineering—Advanced degree preferred. Experience in production, drilling, or other phases of petroleum engineering. Undergraduate and graduate instruction. Nine months. Appointment Sept. 1.

(3) Instructor of Petroleum Engineering—Training and experience in any phase of petroleum engineering. Undergraduate instruction. Nine months. Appointment Sept. 1.

(4) Research Engineer — M.S. degree minimum. Top supervision of A.P.I. Research Project 47B. 12 months. Appointment July 1.

The following temporary part-time appointments are for graduate students. Stipend is fixed.

(1) Graduate Assistant—Half-time devoted to departmental duties such as laboratory supervision. Enrollment as a graduate student with 10 to 12 hours course work per semester. Stipend $810.00 for 9 months.

(2) Research Assistant—Half-time devoted to research on A.P.I. Project 47B. Enrollment as graduate student with 10 to 12 hours per semester of course work. Stipend $1,500 per year.

Interested persons reply to School of Petroleum Engineering, Univ. of Oklahoma, Attention: Dr. John C. Calhoun, Jr. Give full details of training and experience, salary expected and references.

ALL INSTITUTE SECTION

APPEARING IN:
• MINING ENGINEERING
• JOURNAL OF METALS
• JOURNAL OF PETROLEUM TECHNOLOGY

Further Consideration Given by Board to Report of Democratization Committee

Chief topics for discussion at the meeting of the Board of Directors, AIME, in New York on Wednesday, April 20, were the report of the Committee on Democratization and the forthcoming referendum on increased dues. Eighteen Directors, including two alternates, spent 5½ hours in their deliberations, which started with a luncheon meeting at the Engineers' Club, and continued in the Board room at Institute headquarters. President Young presided, with the following directors in attendance: Messrs. Bowles, Daveler, Elkins, Head, Kinzel, Kraft, Meyerhoff, Millikan, Peirce, Schumacher, Suman, Swift, Weed, Wrather, and Fletcher. Mr. Lovejoy acted as alternate for Mr. Watson and Mr. Work substituted for Mr. King.

The essential points made by the Committee on Democratization were reported in the March and April issues of the AIME journals. Mr. Gillson reviewed the report further, emphasizing that the Committee would be satisfied if the spirit of its report were accepted; for the time being, at least, it realized that certain of its suggestions, such as greatly increased traveling by the Secretary, a field secretary for the Mining Branch, and paid expenses of two Local Section delegates to three meetings a year, would be more costly than the Institute would be justified in undertaking. The Board was especially interested in the plan for a more formal organization of the Section delegates' group, and asked the Committee to work up a specific plan for presentation at the September meeting of the Board. There was some discussion as to the desirability of having fewer meetings of the Board, but making them more important, with carefully prepared agenda; it was thought that this would not be opposed to the idea of democratization. The Petroleum Branch reported its feeling that extensive trips into the field by the Secretary should not be necessary if he kept in close touch with the Branch executive committees, who would in turn, keep themselves fully informed of the feeling of the membership at large. The Branch also favored an increased number of younger men on the Board.

As to the progress of the movement to increase dues, approval was voted of the statement appearing over President Young's signature in the May issues of the journals. This was supported by separate editorial appeals in the three journals and mimeographed data prepared by the Secretary's office and distributed to all Directors and Local Section Chairmen. Considerable discussion arose as to the form of ballot for the referendum, and it was finally decided that this should take the form of a postal card which would be signed by the voter, who would not only indicate his approval or disapproval of the proposed increase, but would indicate his Branch affiliation. A reprint of President Young's statement would accompany the ballot. The postal card would be stamped and self-addressed to the Institute, and would be mailed on or about May 20 to all paid-up AIME members in the United States, Can-

AIME STAFF

Secretary EDWARD H. ROBIE
Assistant Treasurer H. A. MALONEY
Assistant Secretaries E. J. KENNEDY, JR.
ERNEST KIRKENDALL
WILLIAM H. STRANG (Dallas, Texas)
Assistant to the Secretary H. NEWELL APPLETON

AIME OFFICERS

President L. E. YOUNG
Vice-Presidents C. H. BENEDICT
A. B. KINZEL
PHILIP KRAFT
D. H. McLAUGHLIN
R. W. THOMAS
Vice-President and Treasurer ANDREW FLETCHER
Secretary EDWARD H. ROBIE

ada, and Mexico, returnable by June 10, so that the results can be reported by officially appointed tellers, representing each Branch, at the June 15 meeting of the Board. The form of referendum ballot is not specifically stated in the bylaws but counsel advised that the proposed postal card meets the requirements for a "letter ballot."

deficit to decrease in 1949

Based on operations for the first quarter, the final budget for 1949, as offered by Mr. Daveler, shows income at $380,350 compared with total expenditures of $437,479, or a deficit of $57,129, to be in part offset by voluntary contributions of $8,500, or a net estimated deficit for the year of $48,629. This would compare with the deficit of $82,000 suffered in 1948. The reduction in the deficit is almost exactly counterbalanced by the expected increase in advertising revenue in 1949 from the three new journals. Details of the budget, which this year for the first time is apportioned to the three Branches, were offered for discussion by the Board. The paid membership is divided approximately in the ratio of 52 percent for the Mining Branch, and 24 percent each for the Metals and Petroleum Branches. Allocating income and expenses to Branches, on the basis of information supplied by members, the deficit for the Metals Branch in 1949 is estimated at $55,122 and for the Petroleum Branch $17,161, whereas the Mining Branch would show a surplus of $23,754.

In view of the fact that many 1948 publications are out of print, the Board voted to allow a credit of $5 to all members in the United States who pay up their dues for 1948 and who cannot be supplied with one or more requested publications. In view of the further difficulty that some foreign members have had in securing American dollars, it was further voted to remit the entire amount of 1948 dues to those foreign members now in arrears for 1948 and 1949 dues. Also, the time was extended to Dec. 31, 1949, in which Junior Members of ten years' standing may change their status to Member or Associate Member without payment of an initiation fee; the date had previously been set at July 1, 1949.

Approval was voted to recommend to the Engineering Foundation that grants be made for certain research projects as follows: $2,500 for Project 97, Diffusion in Steel, by Morris Cohen; $3,000 for Project 98, Mechanical Properties of Binary Alloyed Ferrites at Low Temperatures, by R. M. Brick; and $1,000 for a new project in the field of comminution, by A. Kenneth Schellinger.

1951 annual meeting in St. Louis

Formal acceptance was voted of the invitation of the St. Louis Section to hold the 1951 Annual Meeting of the AIME in St. Louis, which is probably the most centrally situated city in which an Annual Meeting can be held for the convenience of AIME members. The 1950 Annual Meeting will be held at the Hotel Statler in New York, Feb. 12-16. No decision has yet been made as to the scene of the Fall Meeting of the AIME in 1950; it will be impractical to hold it in New Orleans as suggested.

Erle V. Daveler was appointed to represent the Institute on the John Fritz Medal Board of Award succeeding Clyde Williams, resigned. Fred Searls, Jr., was named to succeed H. M. Lavender as chairman of the Saunders Mining Medal Committee, and H. L. Roscoe was named to take Mr. Lavender's place as a committee member. Oliver C. Ralston was reappointed as an AIME representative on the National Research Council. Albert M. Portevin was named to represent the AIME at the centenary celebration of the French Society of Metallurgy in Paris next October.

The Cornell Metallurgy Society, at Cornell University, was formally recognized as an Affiliated Student Society, AIME. Selection of James A. Stangarone as advertising manager of the *Journal of Metals* was reported.

Print Orders for Journals

Institute headquarters was faced with an important problem last December when it became necessary to decide on how many copies of each of the three journals to print, with no knowledge of what the wishes of the members would be. We wanted stocks to be adequate to supply the demand, but did not wish to waste money in printing journals for which there was no need. The print orders for the January issues were finally set at 11,500 for *Mining Engineering*, 6700 for the *Journal of Metals*, and 5500 for the *Journal of Petroleum Technology*. In the light of subsequent information only slight changes had to be made in succeeding issues: 10,800, 6700, and 5400 respectively. All issues of each magazine could be supplied up to May 1 except the January issue of the *Journal of Petroleum Technology*.

Progress of Publication of AIME Volumes

In the December issue of *Mining and Metallurgy*, page 686, was published a list of the volumes whose publication was expected in 1949 and the terms under which members could secure them. The expected dates of publication of these volumes are:

No. 175 Institute of Metals Division. May.

No. 176 Iron and Steel Division. August.

No. 177 Coal Division. August.

No. 178 Mining Geology. May.

No. 179 Petroleum Development and Technology. August.

No. 180 Institute of Metals Division. October.

No. 181 Metal Mining, etc. October.

No. 182 Nonferrous Smelting and Refining. October.

No. 183 Minerals Beneficiation. November.

Open Hearth Proceedings. November.

Blast Furnace Proceedings. November.

Electric Furnace Proceedings. September.

Rod and Wire Symposium. August.

Statistics of Oil and Gas. August.

Industrial Minerals and Rocks. 2d ed. August.

Berwerk—und Probierbuchlein. Now available. $3 members; $5 nonmembers.

Conservation of Petroleum. No date set.

Coal Preparation. Revised edition authorized but no date set.

This is Columbus, home of Ohio State, the Capital, Battelle Memorial Institute, and the AIME Fall Meeting.

AIME General Meeting Set for September

The date has been set, and tentative plans prepared, for the AIME Fall Meeting, to be held this year in Columbus, Ohio. The kickoff, and it will be a real kickoff, is set for Saturday, Sept. 24, which day will be spent at the Ohio State–Missouri football game in Columbus. Registration will be the following day, and Monday will see the beginning of a six-day round of technical sessions, inspection trips, and executive conferences. The meeting will close on Oct. 1, just in time for the Ohio State–Indiana football game.

Twenty-one hours of technical sessions will be held on Monday, Tuesday, Wednesday, and Friday, but Thursday will be reserved for inspection trips which will include the National Electric Coil Co., Jeffrey Mfg. Co., and the Battelle Memorial Institute. Programs are being planned by most of the Divisions of the Institute. A cocktail party and banquet will also be held during this busy week. In addition, the Southern Ohio Section of the Open Hearth Committee, AIME, will meet on Friday, Sept. 30, for technical sessions, luncheon, and an evening banquet. The Open Hearth group's Executive Committee will also meet on the last day of the Meeting, and then be off to see the closing grid-iron tussle.

The Neil House in Columbus will be headquarters for this mid-year general meeting, and those who are planning to attend can write Hugo E. Johnson at the Battelle Institute for further details.

AIME Research Grants Continue

Four AIME research projects, dealing with diffusion of steel; alloys of iron research; basic open hearth steelmaking; and the behavior of metals during hot-working, will continue to receive support this year from the Engineering Foundation, the research department of United Engineering Trustees, Inc., for the Founder Societies, a group founded thirty-five years ago for the ASCE, ASME, AIEE, and AIME.

Although the Foundation's available funds are now only $24,353 or less than half what they were a year ago, that amount will provide grants for a total of thirteen research projects this year. Contributions are made primarily to support studies and analyses necessary to organize projects to a point where they can be supported from other sources. Eighteen such projects were supported during the past year.

EJC Survey on Engineering Employment and Salaries

The General Survey Committee of the Engineers Joint Council, which is composed of representatives of the major engineering societies, has recently concluded a survey of representative industrial companies and governmental agencies concerning their 1949 employment programs for engineering graduates. Of 500 questionnaires sent out late in January, 193 had been returned early in May, but none of these were from strictly mining companies.

Excluding a few small organizations providing incomplete data, there were 162 industrial companies and 31 governmental agencies in this group with over 4 million employes, of whom 89,000 were engineering graduates, or a third of some 265,000 such graduates in the country.

These organizations reported that they had hired 10,390 inexperienced engineering graduates in 1948 and estimated that they would hire 8174, or some 21% less in 1949. For the industrial companies, the decrease was 26% to a total of 5695; for the governmental agencies, 9% to one of 2479. Agencies of the state governments actually expected a substantial increase.

On the basis of the starting rates reported, 25% of these men at the Bachelors' level would receive a starting rate of $275 per month or more, 50% one of $255 or more (the so-called median rate) and 75% one of $250 or more.

The median rates reported by organizations, without regard to the numbers of men to be employed, were $255 for Bachelors', $300 for Masters', and $375 for Doctors' degrees.

A median monthly increase of $30 is given by the end of the first year by the organizations in this group. 45% of them give this total at one time, 49% in two installments, and the remainder in three or four installments.

In order to secure some indication of the recent trend in salaries of engineering graduates with experience, the survey also requested data for those 10 years beyond their Bachelors' degrees late in 1946 and those who were 10 years out late in 1948. Only 82 organizations provided these data and, to some extent, they represent estimates rather than exact figures. For 1511 graduates 10 years out in 1946, the median monthly salary was $375 and for 1431 who were 10 years out in 1948 it was $450, or 20% more. The 1946 figure corresponds closely with that secured by a survey of individual engineering society members at that time, and on that basis the current data for both years may be regarded as reasonably reliable.

Calendar of Coming Meetings

JUNE

2 Reno Branch, Nevada Section, AIME.
3 Columbia Section, AIME.
3-4 Central Appalachian Section, AIME, spring meeting, Blacksburg, Va.
5-10 SAE, summer meeting, French Lick, Ind.
8 El Paso Metals Section, AIME.
13-15 15th National Applied Mechanics Conference, University of Michigan, Ann Arbor.
13-15 Annual convention, Idaho Mining Association, Sun Valley.
14 East Texas Section, AIME.
15 Southwest Texas Section, AIME.
16 Carlsbad Potash Section, AIME.
16 Engineering Foundation, 29 W. 39 St., New York City.
June 27-July 1 ASTM, 52nd annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
20-22 American Society of Heating and Ventilating Engineers, semi-annual meeting, Minneapolis, Minn.
20-24 AIEE, summer general meeting, New Ocean House, Swampscott, Mass.
20-24 American Society for Engineering Education, RPI, Troy, N. Y.
21 Gulf Coast Section, AIME.
25-26 American Iron and Steel Institute, general meeting, N. Y. C.
27-30 ASME, semi-annual meeting, San Francisco.
27 Alaska Section, AIME.
28 Montana Section, AIME.
29 Pennsylvania - Anthracite Section, AIME, summer meeting Split Rock Lodge, Pocono Mountains.

JULY

9-23 Fourth Empire Mining and Metallurgical Congress, Great Britain.
13-15 American Society of Civil Engineers, summer convention, Mexico City.
15-24 Pan-American Engineering Congress, Rio de Janeiro.

AUGUST

23-26 AIEE Pacific general meeting, Fairmont Hotel, San Francisco.
26-Sept. 10 Engineering & Mining Exhibition, London, England.

SEPTEMBER

25-28 Mid-year Meeting, AIME, Neil House, Columbus, Ohio.
25-28 American Mining Congress, Western fall meeting, Spokane.
29-30 ASME, fall meeting, Erie, Pa.
29-Oct. 1 Colorado School of Mines, 75th anniversary celebration.
Sept. 30-Oct. 1 Southern Ohio Section of Open Hearth Committee, AIME, fall meeting, Deshler-Wallick Hotel, Columbus.

OCTOBER

5-7 Petroleum Branch, AIME, fall meeting, Plaza Hotel, San Antonio, Texas.
13-14 Texas Mid-Continent Oil and Gas Association, annual meeting, Rice Hotel, Houston.
14 Eastern Section, Open Hearth Committee, Iron and Steel Division, annual all-day fall meeting, Warwick Hotel, Philadelphia.
14 Southwestern Section, Open Hearth Committee, Iron and Steel Division, Kansas City, Mo.
17-19 Institute of Metals Division, AIME, fall meeting, Allerton Hotel, Cleveland.
17-23 AIEE, 1949 **Mid-West meeting,** Netherland Plaza, Cincinnati.
20-21 Petroleum Branch, AIME, Elks Club, Los Angeles.
24-28 Thirty-seventh National Safety Congress and Exposition, Chicago.
26-27 Joint Fuels Conference. ASME-AIME, French Lick Springs Hotel, French Lick, Ind.
28 Pittsburgh Section of Open Hearth Committee and Pittsburgh Section, AIME, annual fall meeting, William Penn Hotel, Pittsburgh.
28-29 ECPD, annual meeting, Edgewater Beach Hotel, Chicago.

NOVEMBER

1-5 Pacific Chemical Exposition, California Section, American Chemical Society, San Francisco Civic Auditorium.
2-4 American Society of Civil Engineers, fall meeting, Washington, D. C.
7-10 AIChE, annual meeting, Pittsburgh, Pa.
9-11 Industrial Minerals Division, AIME, Tampa, Fla.
12-14 Geological Society of America, annual meeting, Hotel Cortez, El Paso.

DECEMBER

8-10 Seventh Annual Conference, Electric Furnace Steel Committee, Iron and Steel Division, AIME, Hotel William Penn, Pittsburgh.

JANUARY 1950

18-20 American Society of Civil Engineers, annual meeting, New York.
30 AIEE, winter meeting, New York.

FEBRUARY 1950

12-16 Annual Meeting, AIME, Statler (Pennsylvania) Hotel, New York City.

APRIL 1950

10-12 Open Hearth Conference, and Blast Furnace, Coke Oven and Raw Materials Conference. Netherland Plaza Hotel, Cincinnati.
19-21 American Society of Civil Engineers, spring meeting, Los Angeles.

NOVEMBER 1950

16-18 Geological Society of America, annual meeting, Hotel Statler, Washington, D. C.

DECEMBER 1950

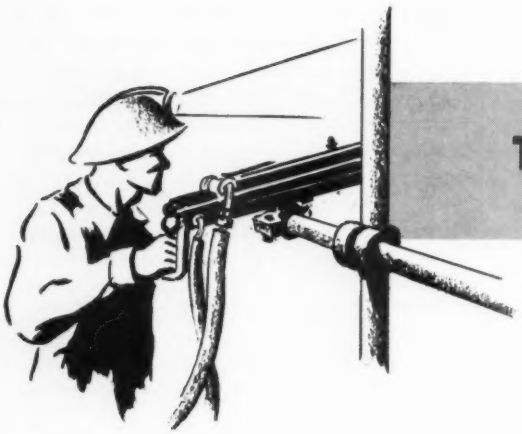
7-9 **Eighth Annual Conference, Electric Furnace Steel Committee, Iron and Steel Division, AIME, Hotel William Penn, Pittsburgh.**

If You Are Visiting Dayton

AIME members visiting Dayton, Ohio, are cordially invited to make use of the facilities of the Engineers' Club of Dayton, 112 E. Monument Ave., one block from the downtown business district. A guest card good for two weeks will be provided upon proper identification. Sleeping facilities are not available, but regular luncheons are served, a reading and billiard room is provided, and there is an excellent library of 10,000 volumes, with 100 periodicals received. William Siler is manager.

What Went on at Recent Local Section Meetings

SECTION	DATE	PLACE	PRESIDING OFFICER	ATTEND-ANCE	SPEAKER, AFFILIATION, AND SUBJECT
Boston	April 4	MIT	George P. Swift	146	Clifford L. Curan, E. B. Badger and Son" s'An Engineer Views the U. S. S. R."
Carlsbad Potash	Mar. 24	Carlsbad	J. P. Smith	69	C. P. Theis, New Mexico state geologist, on ground water.
Carlsbad Potash	April 21	Carlsbad	J. P. Smith	57	E. F. Bunning, Central States Cooperative, on potash's use in fertilizers.
Carlsbad Potash	April 23	Carlsbad	J. P. Smith	146	Annual spring dance.
Chicago	April 6	Chicago Bar Association	T. S. Washburn	83	J. S. Smart, Jr., American Smelting and Refining Co., on ASARCO continuous casting process.
Cleveland		Cleveland			Harold Hunsicker, Aluminum Co. of America, on precipitation hardening of aluminum alloys.
Cleveland	April 14	University Club		22	Dinner meeting. John Love, business analyst, Cleveland Press, on aspects of the economic landscape.
Columbia	April 1	Spokane, Idaho	Howard P. Sherman	61	Robert D. Dallwo, attorney, on Communist technique and strategy.
Connecticut	April 13	Bridgeport	H. L. Burghoff	58	A. D. Eplett, Manning, Maxwell and Moore, "Technological Observations in Postwar Germany."
Delta, Mississippi Subsection	April 21	Laurel, Miss.	R. E. France	82	Walter F. Rogus, Gulf Oil Corp., on condensate well corrosion. E. N. Dunlap, California Research Corp., on AIME Annual Meeting.
Detroit	April 18	Detroit	Eric Weinman		W. L. Grube, General Motors Corp., on the electron microscope as a metallurgical tool.
El Paso Metals	April 13	Texas College of Mines	Jack Despins	38	Baxter Polk, Texas College of Mines and Metallurgy, on the library for student and professional engineers.
Lehigh Valley	Mar. 25	Bethlehem	F. E. Van Voris	103	Bruce S. Old, Arthur D. Little, Inc., on radioactive tracers in metallurgy and coke production. A. M. Gaudin, MIT, on radioactive tracers in mineral engineering.
Montana	Mar. 29	School of Mines, Butte	Hollis McCrea	130	S. P. Nile, Montana School of Mines, on radioactivity.
Montana	April 26	Anaconda Copper M. Corp.			Visit to Anaconda ferromanganese plant. R. H. Townsend, superintendent of zinc roasters, on ferromanganese operations.
New York	Mar. 10	Mining Club	Thomas G. Moore	69	Claude A. Williams, President, Transcontinental Gas Pipe Line Corp., on natural gas.
New York	April 13	Mining Club	T. B. Counselman	87	J. A. Retty, chief geologist, Labrador Mining and Exploration Co., on the Hollinger-Hanna Iron Ore development in New Quebec and Labrador.
Nevada, Reno Branch	Feb. 3	Reno	L. D. Gordon		Silas E. Ross, Chairman, Board of Regents, University of Nevada, on The Board of Regents and the Law.
Nevada, Reno Branch	May 5	Reno	A. C. Johnson	44	Business meeting. Mackay School of Mines Day.
North Pacific	April 21	Seattle	Kenneth Anderson	52	Field trip, Boeing Airplane Co.
Pennsylvania-Anthracite	April 22	Altamont Hotel, Hazelton	Harry Otto		Spring meeting. S. H. Ash, chief, Safety Branch, U. S. Bureau of Mines, "Anthracite Flood-Prevention Project."
St. Louis	Jan. 21	Hotel York	Herbert A. Franke	70	Davis Read, chief engineer, West Kentucky Coal Co., on Coal Mine Mechanization. C. E. Davis, Goodyear Rubber Co., comments on film, "The Way Out."
St. Louis	Mar. 18	Hotel York	Herbert A. Franke	36	Fred B. Loomis, Shell Oil Co., on oil exploration. Paper prepared by Ernest G. Robinson.
St. Louis	April 22	Hotel York			J. G. Evans, Gardner-Denver Co., motion pictures taken in South Africa.
San Francisco	April 13	Engineers Club	E. H. Wisser	39	James T. Kemp, American Brass Co., on Cornish mine pumping engines.
San Francisco	Mar. 9	Engineers Club	E. H. Wisser	84	Edward Morris. Movies on California's gold mines.
Southwestern New Mexico	Mar. 16	Bayard	Joseph H. Taylor	27	W. H. Goodrich and W. R. Storms. Reports on AIME Annual Meeting.
Southwestern New Mexico	April 13	Bayard	Joseph H. Taylor	61	E. A. Slover, Chino Mines Division, Kennecott Copper Corp., on practices at Hurley copper smelter. E. M. Tittmann, American Smelting & Refining Co., "El Paso Zinc Fuming Plant."
Ohio Valley	April 11	Columbus	William Mueller	40	William Mueller, Department of Metallurgy Ohio State University, delegates report on annual meeting. Hugo Johnson, Battelle Memorial Institute, explanation of new Section by-laws and discussion of plans for mid-year or Regional meeting.



THE DRIFT OF THINGS

. . . as followed by EDWARD H. ROBIE

The Peak Is Passed

At last the postwar boom in metal prices has ended, and some mining companies, operating high-cost properties, will now have to curtail or close down. Copper at 23½¢ was high but not to be compared with lead at 21½¢, so the price of the former offered more resistance to decline, and began with but a slight shading by one seller. Lead, on the other hand took a headlong tumble, in less than a month, from 21½¢ to 16¢, and then dropped still further, to 14¢, by the middle of May. Zinc never got up to the price of lead, though before the war it ruled somewhat higher. From a high of 17½¢ it had dropped to 14¢ in mid-May. Copper was 18¢.

The high prices had the normal effect of stimulating an enormous amount of exploration and development work, and plant extensions. In a large number of instances the geologists have been successful, as Donald M. Davidson showed in his most interesting article in the March *Mining Engineering*. Important new metal mines are springing up all over the world. Unfortunately most of them will come into production when the demand has quieted down, and their added pressure on the market will drive prices still lower. Mineral production cannot respond to prices as quickly as can that of many other commodities.

Coal and oil, likewise, are in ample supply, but the price of oil never boomed like the prices of the nonferrous metals, so has better resisted a decline. Coal has been more nearly in line with the cost of production, so until wages come down, which we understand Mr. Lewis is not planning, no great cuts in price are likely there.

Though the metal mines will get less for their product from now on, there will be compensations. Labor will be easier to get and will work harder, and the cost of supplies will be less.

Good Times or Bad Times?

Our electrician, whom we called in the other day only to find a blown fuse that we did not have intelligence enough to find ourselves, told us that now he is really glad to have work, and no longer is trying to escape it. He says helpers are much easier to get too, and what's more they work instead of sitting around talking. This condition seems to be returning in all fields of activity. Even in professional mining, more people are looking for jobs, and less employers are calling for men. If not carried too far, the condition is a healthy one, and makes for better work habits. It will, of itself, reduce the number of jobs, however, for if everybody works ten per cent harder, then ten per cent less people will be needed to do the country's work. A diligent person, can, we suspect, still find something to do.

Buyers' Market for Graduates, Too

Engineering graduates this year are not able to sit back and take their choice of several offered jobs, which is the condition that has existed in recent years. The supply of graduates is increasing and the demand, owing to the recession in industrial activity, is decreasing. Many graduates that expected employers to come after them have found that they must go out and rustle jobs for themselves.

Employers tells us that where half the offers they made to students have been rejected in the last few years, the proportion is now only about 25 percent, and that most of this 25 percent is made up of men who plan to take graduate work or who have decided to work in local areas close to their homes. The increasing proportion of students that plan to take graduate work, in part because they cannot get attractive jobs, will make it just that much harder for those with Bachelors' degrees to get jobs in the years to come.

Also, we learn from employers that the character of the present crop of graduates has changed. Heretofore, most of them had had actual military service, and many had held commissions—in general a most desirable group, earnest, mature boys, trained in administration and supervision as well as in their technical specialty. Now, they are classifiable for the most part into two groups—(1) really outstanding boys and (2) graduates that should never have gotten that far in their schooling, the "4F's in the head," who went to college because there was nothing else to do and they could do so at the taxpayers' expense. They have not had much military experience—mostly just in camps. Even with a degree they will have rather hard sledding this year. The first group, however, the cream of the crop, should have no particular difficulty locating a satisfactory job even though they may have to go after it instead of it coming to them.

Gold Output Still Lags

U. S. Gold output last year was valued at 73 million dollars—just about half what it was before the war. The picture for the gold mines, however, is not as bright even as that might indicate, for most of the gold is obtained as a by-product, and would be produced whatever the price. Homestake is about the only straight gold mine of any importance left in the country. Canada has more gold mines by far; its output last year got back up to 123 million dollars, compared with 143 million in 1937. The freer labor supply and the current reductions in the price of supplies will redound to the advantage of the gold mines but it will take a real depression to make them prosperous. That is, unless the Government decides on what seems to us the sensible course of letting the gold miners sell their product freely for whatever it will bring. Certainly less than a hundred million dollars' worth of gold exported from the country in a year will not upset the international monetary commission.

Before we leave the subject of gold we might repeat an advertisement that the *New York Herald Tribune* reprints from an issue published 100 years ago: "Seekers after gold in the rivers and streams of California will need a suit of India-rubber to protect them from wet in their researches. Complete outfits of this material, coats, caps, boots, pantaloons with boots attached, camp blankets, life preservers, canteens, pails for collecting the gold &c. &c. for sale to enterprising adventurers at low prices by Ellis Tompkins & Co., New India-Rubber Warehouse, 28 John St." The pails for collecting the gold are now but rarely used.

$5-a-Ton Oxygen

Metallurgists have been using more oxygen in the last decade or so than ever before. Compared with air it speeds up reactions and thus gives added capacity. A considerable fillip to this use may result if its cost can be cut by any such figure as is indicated by news of a plant in Texas built by Dresser Industries. This plant is said to have attained an output of more than 175 tons of 90-95% oxygen a day at a cost of only $5 per ton. Although this is somewhat lower in grade than the 99% oxygen ordinarily used in large quantities, the cost is only about a tenth as much. The difference in grade should not be of any particular importance in most metallurgical processes, but any such difference in cost should open up an enormous new field of application.

We have not read the details of the new process other than that it depends on a low-pressure self-contained cycle, using only cooling water and natural gas for fuel. Air is compressed to 85 lb, and then cooled by expansion and self-refrigeration. Carbon dioxide and other impurities are removed by deposition on special aluminum fin-tube exchangers, and the oxygen and nitrogen separated in aluminum fractionating columns.

Scientific vs Legal Minerals

Down in Texas, Mrs. Emilie Heinat had willed surface rights to her 400-acre farm to a daughter, and the mineral rights to trustees for all of her children. When it was found that limestone could be produced commercially on the property, those to whom the mineral rights had been willed sued for possession of the property. The trial court held that limestone is a mineral, so the mineral owners should have the farm. The Court of Civil Appeals disagreed, and the Texas Supreme Court upheld the appeal. The interpretation of mineral rights was given by Associate Justice Smedley as follows:

"Substances such as sand, gravel, and limestone are not minerals within the ordinary and natural meaning of the word unless they are rare and exceptional in character, or possess a peculiar property giving them special value, as for example sand that is valuable for making glass, and limestone of such quality that it may be profitably manufactured into cement. Such substances, when they are useful only for building and road-making purposes, are not regarded as minerals in the generally accepted meaning of the word."

So, according to the newspaper report, "Limestone is not a legal mineral, although it may be a scientific mineral"! This is just so that our readers will be informed of the distinction, should they ever be asked.

An Apposite Title

Three years ago we suggested that the title "Honorable" might better be applied to engineers than to lawyers and politicians. There was no apparent stampede to adopt our excellent suggestion, but we note with approval that the seed we sowed at that time has finally sprouted. In its announcement of "National President's Night" on May 2 the Pittsburgh Section of the AIME offers an illustrated talk by

The Honorable Lewis E. Young
Consulting Mining Engineer
President AIME

Even more than Brutus, Dr. Young is an honorable man. So are all engineers, all honorable men.

We Are Threatened

One of our Communist members apparently does not share our expressed belief in the last issue that the North Atlantic Pact is desirable, for we have received an anonymous communication in big black print (no skull and crossbones however) that says: "North Atlantic Pact Means the Beganing of Wa #III and the End of America and You!" [sic] With only a slight tremble, we agree that our friend may be right, but the alternative, as we see it, is to let the Communists take over the world peaceably, and we prefer to take the chance of standing our ground with a gun.

Gold in the Black Hills

Robert J. Casey has just published a book entitled "The Black Hills and Their Incredible Characters," and those interested in the folklore of one of our oldest mining districts will find much in it of interest. It includes, of course, the story of the biggest gold mine in the United States, the Homestake, and of other attempts to mine gold in the district. "It seems strange to me that there should be so little successful mining of precious metals in these parts today," the author reports himself as saying to Chambers Kellar, general counsel for the Homestake. "Surely there is as much gold in the ground as was ever taken out." "Well," said Mr. Kellar, "that is one theory. The other theory is that there isn't."

The matter was never so clearly stated in an AIME T.P.

Among the Student Associates

This "rogues gallery" represents about half of the 100 members of the Mackay School of Mines' Crucible Club. President A. H. Barrios is seen at extreme left.

Lafayette College

The John Markle Society's last technical meeting of the year was held on April 26. It was highlighted by a spectacular demonstration of velocity power tools, given by W. S. McConnell, of the Mine Safety Appliances Co. A slide film, "The Changing World," was also presented, with a commentary by William Shaffer, metallurgical engineer of the class of '49. Society members wound up the session with the usual refreshments.—*John Siergiej, Jr., Secretary.*

Louisiana State University

The reactivated Student Chapter at LSU has been busy meeting bimonthly to hear interesting speakers, and arranging a student paper contest. Dan Grady, of the Hycalog Co., addressed the March 24 meeting, presenting a paper on "Hydrocarbon Profiles in Mud Logging." On April 7, J. E. Smith, of the Johnston Oil Field Service Corp., offered his paper entitled "Drill Stem Testing Procedure in Open Hole."

The Chapter is now engaged in a student paper competition, the winners of which will present their work before the Delta Section, AIME, sometime in April.—*Mahlon F. Manville, Corresponding Secretary.*

Yale University

At its Dec. 2 meeting, the Yale Metallurgical Society was addressed by Richard J. Christine, metallurgist of the American Brass Co. at Torrington, Conn. Mr. Christine discussed the question of what industry expects of the newly graduated metallurgist. The personal relations of the engineer in industry were emphasized, and Mr. Christine told some of his interesting experiences. Following the formal address questions were asked and discussion ensued. The February 15 meeting was addressed by I. J. Hook, research Engineer of American Brass Co., Ansonia, Conn. The Society's President, Denis A. Nankivell, introduced Mr. Hook, who discussed the general aspects of Anaconda copper production in the Montana area before showing a movie on this subject. The movie covered the mining, smelting, and refining of copper in the district. Mr. Hook concluded his address, and the meeting, with a discussion period. About twenty-five members attended the meeting.—*Voluntine T. Potter, Secretary.*

Current Institute Papers

The following papers in the three journals are available to Institute members. Each member will receive one classification in the journal of his choice. Members may obtain papers in the two remaining classifications by purchasing the indicated issue of the journal at $0.75 per copy. There are no separate copies of the individual papers. ME means Mining Engineering, JM Journal of Metals, and JPT Journal of Petroleum Technology.

Metals Papers

Cadmium Recovery Practice in Lead Smelting. By P. C. Feddersen and H. E. Lee. February JM.

Development of Muffle Furnaces for the Production of Zinc Oxide and Zinc at East Chicago, Ind. G. E. Johnson. February JM.

The Effect of Orientation Difference on Grain Boundary Energies. By. C. G. Dunn and F. Lionetti. February JM.

Solubility Relationships of the Refractory Monocarbides. By J. T. Norton and A. L. Mowry. February JM.

Pressure Distribution in Compacting Metal Powders. By Pol Duwez and Leo Zwell. February JM.

Preferred Orientation in Rolled and Recrystallized Beryllium. By A. Smigelskas and C. S. Barrett. February JM.

Self-Diffusion in Sintering of Metallic Particles. By G. C. Kuczynski. February JM.

Homogeneous Yielding of Carburized and Nitrided Single Iron Crystals. By A. N. Holden and J. H. Hollomon. February JM.

The Surface Tension of Solid Copper. By H. Udin, A. J. Shaler, and John Wulff. February JM.

The Ionic Nature of Metallurgical Slags —Simple Oxide Systems. By John Chipman and Lo-Ching Chang. February JM.

Properties of Chromium Boride and Sintered Chromium Boride. By S. J. Sindeband. February JM.

Magnesium-Lithium Base Alloys—Preparation, Fabrication, and General Characteristics. By J. H. Jackson, P. D. Frost, A. C. Loonam, L. W. Eastwood, and C. H. Lorig. February JM.

The Recovery of Cadmium from Cadmium-copper Precipitate By G. H. Anderson. March JM.

Electrolytic Zinc at Risdon, Tasmania, Major Changes Since 1936. By S. W. Ross. March JM.

The Hardenability Effect of Molybdenum. By J. M. Hodge, J. L. Giove, and R. G. Storm. March JM

A Method of Examination of Fine Metal Powder Particles with the Electron Microscope. By Laurence Delisle. March JM.

The Effect of Ferrite Grain Size on Notch Toughness. By J. M. Hodge, R. D. Manning, and H. M. Reichhold. March JM.

Recrystallization and Microstructure of Aluminum Killed Deep Drawing Steel. By R. L. Rickett, S. H. Kalin, and J. T. MacKenzie, Jr. March JM

Precipitation Phenomena in the Solid Solutions of Nitrogen and Carbon in Alpha Iron Below the Eutectoid Temperature. By L. J. Dijkstra. March JM.

Concentration of the So_2 Content of Dwight-Lloyd Sintering Machine Gas by Recirculation. By W. S. Reid. April JM.

The Crystal Structure of Ni_4W. By E. Epremian and D. Harker. April JM.

Sulphur Equilibria Between Iron Blast Furnace Slags and Metal. By G. G. Hatch and John Chipman. April JM.

The Beryllium-iron System. By R. J. Teitel and Morris Cohen. April JM.

Discussion, Institute of Metals Division. May JM.

The Effect of High Copper Content on the Operation of a Lead Blast Furnace, and Treatment of the Copper and Lead Produced. By A. A. Collins. May JM.

What is Metallurgy? By John Chipman. June JM.

The Sigma Phase in Ternary Cr-Co-Fe and Cr-Co-Ni Alloys. By P. A. Beck and W. D. Manly. June JM.

Distillation of Zinc From Copper Base Alloys and Galvanizers Drosses. By F. F. Poland. June JM.

Cadmium Recovery Practice at the Donora Zinc Works. By G. T. Smith and R. C. Moyer. June JM.

The Statistical Nature of the Endurance Limit. By J. T. Ransom and R. F. Mehl. June JM.

Investigation of Temper Brittleness in Low-alloy Steels. By S. A. Herres and A. R. Elsea. June JM.

Oriented Arrangements of Thin Aluminum Films on Ionic Substrates. By T. N. Rhodin, Jr. June JM.

P-type and N-type Silicon and the Formation of the Photovoltaic Barrier in Silicon Ingots. By J. H. Scaff, H. C. Theuerer, and E. E. Schumacher. June JM.

Microstructures of Silicon Ingots. By W. G. Pfann and J. H. Scaff. June JM.

Mining Papers

Alluvial Tin Mining in Malaya. By A. D. Hughes. March ME.

Sampling of Coal for Float and Sink Tests. By A. L. Bailey and B. A. Landry. March ME.

Drilling Blastholes at the Holden Mine with Percussion Drills and Tungsten Carbide Bits. By E. A. Youngberg. March ME.

Aerial Photographic Contour Maps for Strip Mines. By George Hess and R. H. Swallow. April ME.

Drying of Low-rank Coals in the Entrained and Fluidized State. By V. F. Parry, J. B. Goodman, and E. O. Wagner April ME.

Coal Washing in Colorado and New Mexico. By J. D. Price and W. M. Bertholf. April ME.

The Rupp-Frantz Vibrating Filter. By W. M. Bertholf and J. D. Price. April ME.

Synthetic Liquid Fuels from Coal. By J. D. Doherty. April ME.

Drilling and Sampling Unconsolidated Materials. By L. W. Dupuy. May ME.

Effects of Rod Mill Speed at Tennessee Copper Co. By J. F. Myers and F. M. Lewis. May ME.

Temperature Compensation of Old Type Askania Magnetometers. By T. Koulomzine. May ME.

Municipal Water Needs vs. Coal Mine Stripping. By G. M. Dexter. May ME.

Correlation of the Performance Characteristics of Domestic Stoker Coals With Their Chemical and Petrographic Composition. By R. J. Helfinstine and G. H. Cady. May ME.

Ready-Made Heat From Coal. By D. W. Loucks. May ME.

Sinking With the Hydro-mucker at Mather "B" Shaft. By J. S. Westwater. June ME.

Diamond Drilling Quartz-feldspar Intergrowths. By L. C. Armstrong. June ME.

Safety Practices at the Crestmore Mine of the Riverside Cement Co. By R. H. Wightman and G. H. Adams. June ME.

Sintering Characteristics of Minus Sixty-five and Twenty Mesh Magnetite. By Alan Stanley and J. C. Mead. June ME.

Humphreys Spiral Concentration on Mesabi Rrange Ores. By W. E. Brown and L. J. Erck. June ME.

Formation and Properties of Single Crystals of Synthetic Rutile. By C. H. Moore, Jr. June ME.

Coal Washing in Washington, Oregon and Alaska. By M. R. Greer and H. F. Yancey. June ME.

A Study of Coal Classification and Its Application to the Coking Properties of Coal. By Michael Perch and C. C. Russell. June ME.

An Evaluation of the Performance of Thirty-three Residential Stoker Coals. By J. B. Purdy and H. W. Nelson. June ME.

Work of the U. S. Geological Survey on Coal and Coal Reserves. By Paul Averitt. June ME.

Petroleum Papers

Semi-automatic Power-Operated Drilling Machinery. By M. E. True and B. L. Stone. February JPT.

The Core Recorder. By Clark Millison. February JPT.

Capillary Pressures—Their Measurement Using Mercury and the Calculation of Permeability Therefrom. By W. R. Purcell. February JPT.

Effects of Transient Conditions in Gas Reservoirs. By D. T. MacRoberts. February JPT.

Outline of Weather and Wave Forecasting Techniques. By A. H. Glenn and J. E. Graham. February JPT.

A Study of Oil and Gas Conservation in the Pickton Field. By J. R. Welsh, R. E. Simpson, J. W. Smith, and C. S. Yust. March JPT.

Methane Hydrate at High Pressure. By Riki Kobayashi and D. L. Katz. March JPT.

Method of Establishing a Stabilized Backpressure Curve for Gas Wells Producing From Reservoirs of Extremely Low Permeability. By E. R. Haymaker, C. W. Binckley, and F. R. Burgess. March JPT.

Gas Hydrates of Carbon Dioxide-Methane Mixtures. By C. H. Unruh and D. L. Katz. March JPT.

Gas Hydrates of Carbon Dioxide-Methane Mixtures. By C. H. Unruh and D. L. Katz. April JPT.

Gulf of Mexico Floating Drilling Tender. By C. P. Besse and G. W. Osborne. April JPT.

Estimation of Reserves and Water Drive From Pressure and Production History. By E. R. Brownscombe and Francis Collins. April JPT.

Relation Between Pressure and Recovery in Long Core Water Floods. By J. N. Breston and R. V. Hughes. April JPT.

News of AIME Members

Harry L. Kirkpatrick

Alvey B. Rushton

George R. Eadie

Two more outstanding coal mining students, **Harry L. Kirkpatrick** of the University of Kentucky, and **Alvey B. Rushton,** of Lehigh University, have been honored by the Old Timers Club for scholastic excellence and evidence of being "likely to succeed." In addition, the Club has chosen **George R. Eadie** for citation as the most outstanding mining graduate of the year.

Mr. Kirkpatrick, who will receive his B.S. degree in June, was awarded an engraved gold watch at a general engineering assembly on Feb. 10 by **E. R. Price,** chairman of the AIME Coal Division. The lucky recipient is from Lexington, Ky., married, and the grandson of Harry L. Kirkpatrick, long prominent in the Western Kentucky coal industry.

Mr. Rushton hails from New Kensington, Pa., and is following in his family's footsteps in entering the coal industry. He's a veteran of two years' wartime service with the Marines, and was elected to Tau Beta Pi at Lehigh, which school he entered in 1944. **J. Ray Ulrich** made the gold watch award on March 24.

Mr. Eadie graduated from the University of Illinois in February of this year, and is now employed by the H. C. Frick Coal Co., Pittsburgh. His three years in the Army Air Forces followed a stint at the University of Southern Illinois, and then postwar studies brought him to the Missouri School of Mines, which he attended until 1948. Last summer he worked in the engineering department of the Mt. Olive and Staunton Coal Co., before returning to the University to take his degree. **Paul Weir,** president of the Old Timers Club, and head of the Paul Weir Co., Chicago, made the award, an engraved gold pocket watch, at the March 8 meeting of the Mineral Industries Society.

James Boyd, Director of the U. S. Bureau of Mines, will be the principal speaker at the Montana School of Mines Commencement exercises on June 10.

R. K. Comann in November of last year was transferred from the U. S. Gypsum Company's Plaster City, Calif., plant to the home office in Chicago. Since that time he has been in the engineering department and now is working at the Staten Island, N. Y., plant.

Walter B. Jones, state geologist of Alabama, was elected president for 1949-1950 of the Association of American State Geologists at its annual meeting in San Francisco. He succeeds **Garland Peyton,** director of the Georgia Department of Mines, Mining, and Geology.

Harry L. McKelvey has left La Luz Mines Ltd., Siuna, Nicaragua, to accept the post of mine superintendent with the New Idria Honduras Mining Co. at Santa Rosa de Copan, Honduras.

John A. Reeves, former University of Utah student, is assistant mining engineer for the Independent Coal and Coke Co., Kenilworth, Utah.

Jack W. Reinhart is a junior geologist for the American Smelting and Refining Co., Silver City, N. Mex.

A. E. Ring retired from active service as manager of the Southwestern division of the Western mining department of the American Smelting and Refining Co. on March 1. He is at home at 2001 E. Elm St., Tucson, Ariz.

K. A. Rogers has moved to Phoenix, Ariz., from Chippewa Falls, Wis. He had been with the Bureau of Mines and is now engineer with the Davis Dam Transmission System, Parker Dam, Calif.

James A. Ross has been elected first vice-president of the Industrial Diamond Association of America.

Morris E. Sandvig, University of Minnesota man, is a testing engineer for the Erie Mining Co., Aurora, Minn. His mailing address is Box 147, Aurora.

John T. Schimmel is time study engineer for the Consolidation Coal Co., Rivesville, W. Va., and can be reached at 108 Chicago St., Fairmont, W. Va.

Howard G. Schoenike is a geologist with the M. A. Hanna Co. at Iron River, Mich. He was previously employed as a geologist for Butler Brothers, who recently sold their interest to M. A. Hanna.

Dorner T. Schueler, Jr., has the job of engineer with the Industrial Minerals and Chemical Co., Berkeley, Calif., and is addressed in that city at 1155 Calusa Ave.

U. S. Smelting Staff Changes at Midvale

Robert Wallace retired on April 1 as manager of the Midvale plant of the U. S. Smelting Refining and Mining Co. after 33 years of continuous service with the Company, beginning on Jan. 13, 1916, when he was employed as general roaster foreman. By 1924 he was superintendent of the Midvale plant and in 1939 he became its manager. He now winds up 44 years of interesting work and achievement in the mining and smelting industry. After graduating from Harvard in 1905 he went to work in the engineering department of the Cleveland-Cliffs Iron Co., departing from Ishpeming for Old Mexico where he was mining engineer for the AS&R at their properties in Santa Eulalia and Sierra Mojada. Back in the States in 1909, he worked for the Mammoth Copper Co., and the American Zinc, Lead and Smelting Co. In 1914 he went to Utah to work at the Utah Apex in Bingham as a metallurgist in the concentrator. Mr. Wallace recalls that while he was metallurgist of the mill during 1914 and 1915 flotation machines were installed to extract lead minerals from the ore and this, he believes, was the first application of flotation to concentrate lead ores that was made in the State of Utah.

Hugo L. Johnson became general superintendent of the Midvale plant of the U. S. Smelting Refining and Mining Co. on April 1 and has direct charge of all operations of the plant and of the ore purchasing department formerly handled by Mr. Wallace. Mr. Johnson started with the Company 33 years ago as a draftsman in a subsidiary, the U. S. S. Lead Refinery. In 1918 he was made supervisor of the employe service department and four years later became superintendent of the silver refinery. In 1931 supervision of the engineering and maintenance department was added to his duties. He then transferred to Utah as superintendent of the gold and silver parting plant at Midvale which was built in 1933 along with the Parkes process lead refinery. Continuing his upward motion, he was in charge of the construction and operation of a pilot zinc plant, night superintendent at Midvale, assistant smelter superintendent, and in 1946 was made assistant to the manager of the plan, which position he held until his recent promotion.

Archie A. Nelson, who has been research engineer and who will continue to direct that work, has been appointed assistant smelter superintendent. He succeeds **W. M. Whitecotton,** who has been assistant smelter superintendent and in charge of blast furnace operations, and who requested that he be relieved of the responsibility of these posts because of his health. Mr. Whitecotton will remain at the plant as research engineer. Mr. Nelson has been with the Midvale plant for the past twenty years except for six years as mill superintendent and assistant manager of a company subsidiary, MicMac Mines Ltd. in Canada. Mr. Whitecotton was foreman of the cadmium plant of Midvale in 1915 and 1916, after which he was with the Electrolytic Zinc Co. of Australasia as superintendent of its zinc plant at Hobart, Tasmania, until 1922 when he returned to this country. After eleven years in various places, he returned to Midvale as roaster superintendent.

M. J. Belich has become general roaster foreman at Midvale. He has worked there since he finished his studies at the University of Utah on the 1939 W. H. Eardley scholarship in metallurgy awarded by the Company. Since 1946 he has been night superintendent.

John F. Schultze is a metallurgist in the Leadville milling unit of the American Smelting and Refining Co., Leadville, Colo. He receives his mail there at Box 27.

R. R. Schultz has resigned from his post with the Nordberg Mfg. Co. to become sales manager of the Willamette Iron and Steel Co., Portland, Oreg.

John E. Schumacher, Jr., although addressed at P. O. Box 689, Pottsville, Pa., is a field geologist for the Stanolind Oil and Gas Co., Casper, Wyo.

Henry E. Schweinsberg, former vice-president and sales manager of the Fields Mfg. Co., is president of CARBIT, Inc., Highland Bldg., Pittsburgh 6, Pa.

George C. Selfridge has been appointed mine superintendent of the Fresnillo and Zacatecas mines of the Fresnillo Co., Fresnillo, Zac., Mexico. He was formerly associated with the Manhattan District and the Atomic Energy Commission as chief of the exploration branch, raw materials division.

Paul Semko is chief of party of the geophysical exploration division of the Pennsylvania Turnpike Commission, doing geophysical field operations and earth resistivity determinations. His address is 646 Warren Ave., Kingston, Pa.

Arthur E. Shannon is sales engineer for the Jeffrey Mfg. Co., with a mailing address at P. O. Drawer 1078, Morgantown, W. Va.

Charles Gottschalk

Charles Gottschalk spent a month this spring in the States visiting his son and family in Baltimore after completing a two-year assignment in Japan as consultant on coal production problems. He is attached to the economic section of Military Government and expected to report back for duty early in May.

Ely Silverman, of the Tennessee Copper Co., is in Oak Ridge, Tenn., studying the techniques of using radioisotopes in research. He is one of 32 scientists from the States and several foreign countries enrolled in the seventh in a series of one-month courses offered by the Oak Ridge Institute of Nuclear Studies.

Raymond L. R. Slacke is employed by the National Coal Board, West Midlands division, in the capacity of area coal preparation engineer, Shropshire and South Staffordshire area, England.

R. Cecil Smart presented his paper on the Restoration of Productive Efficiency in Britain's Coal Industry before the Economic Reform Club and also before the Association of Colliery Managers, on Feb. 10. The paper's value was attested by the fact that a number of members of the National Coal Board attended his lecture, including representatives from the London office of the Board. His papers will be published in the proceedings of the National Association of Colliery Managers and quoted in the Iron and Coal Trade Review.

C. T. Smith, after 32 years as secretary and treasurer of the Missouri Co-

Mr. Mudd receiving citation for Egleston Medal from C. P. Davis, president of Columbia's Engineering School Alumni Association.

Harvey S. Mudd spoke on the importance of physical metallurgy in counteracting the depletion of our mineral resources at a meeting of the Columbia University Engineering School Alumni Association at which he was awarded the Egleston Medal for distinguished engineering achievement. He said in part:

"The second World War has given rise to much debate about the exhaustion of our mineral resources and in the name of conservation many measures have been proposed. That exhaustion is taking place cannot be denied. It is the rate of exhaustion that now gives concern, and properly so, but it should not be viewed with too great alarm.

"I cannot convince myself that the advance of civilization will be retarded by a deficiency of mineral resources, providing one condition is met, which condition is that research in the fundamental and applied sciences and engineering is wisely and generously supported. Our physical metallurgists are offering new alloys and new processes that give materials having superior properties to engineers with which to work and it is incumbent upon the engineers to make the best use of them, always with the future in mind."

In discussing his talk Mr. Mudd expressed concern over the relatively few students being graduated in metallurgical engineering as compared to other fields of engineering, and the need for metallurgical engineers in research and industry. He noted that research work required a particular type of individual with postgraduate training. Research work being done now in universities not only produced needed information but either directly, or through the faculty, helped to teach research techniques and helped universities to hold some exceptionally talented faculty that they could not otherwise hold.

He commented on the rapid industrial recovery being made in many of the western European countries. He was opposed to both direct subsidies and high tariffs, and pointed out that under normal conditions both were extravagant and interfered with free enterprise.

---

balt Co. of Fredericktown, Mo., has resigned that post and now has retired from active business. Previous to joining Missouri Cobalt, he was accountant for El Oro Mining and Railway Co. at El Oro, Mexico. Mr. Smith can be reached at 118 E. Coolidge St., Harlingen, Texas.

Richard A. Smith retired as state geologist on the Michigan Geological Survey in 1946. Now he is special lecturer in geology at Michigan State College and is doing consulting work.

Robert E. Sorenson has been made chief engineer of the Hecla Mining Co. at Wallace, Idaho.

H. A. Steane has been appointed to the post of mill superintendent of Uruwira Minerals Ltd., Mpanda, via Uvinza, Tanganyika.

J. B. Stapler recently received appointment as managing director of Marsman Hongkong China, Ltd., P. O. Box 500, Hongkong & Shanghai Bank Bldg., Hongkong. Mr. Stapler has been with the Marsman interests for sixteen years and prior to the war was one of the senior engineers of Marsman & Co. The rapid development of mines such as Itogon, San Mauricio, and United Paracale, was largely due to his capable direction. Since his return from internment he has been a director of Marsman Investments, Ltd., and connected with the Marsman Co. of California directing from San Francisco the operations on Okinawa. Mr. and Mrs. Stapler departed on the President Cleveland March 9 for Hongkong where Mr. Stapler will take over his new duties.

Forest J. Sur, mining engineer and geologist formerly with the Bureau of Mines and now with Joe T. Juhan, recently completed a six-month examination and report on an oil shale project near Meeker, Colo., for Juhan and Associates. This done, he went to Farmington, N. Mex., to complete a reconnaissance of San Juan County, with the object of choosing sites for drilling deep wells to Pennsylvanian formations. He spent seven months on this work last year.

William H. Swayne, formerly in the geological department of the Anaconda Copper Mining Co., has gone to Santiago, Chile, as exploration geologist for Cia. Sud Americana Exploradora de Minas.

Ray E. Tower has resigned as general superintendent of the Mica Mountain Mines, South Pass City, Wyo. His new address is 621 S. W. Temple St., Salt Lake City. He is currently interested in mine development in the Masonic area, Mono County, Calif., and in the Tintic area in Utah.

Max A. Tuttle for the past 22 years has been employed by the Knox Consolidated Coal Corp. On Dec. 16, 1948, he became associated with the Enos Coal Mining Co., 1405 Merchants Bank Bldg., Indianapolis 4, Ind.

Gailen T. Vandel has accepted a post with the Cerro de Pasco Copper Corp. in Peru and expected to leave the States early in March.

Roy Van Zante, who was addressed at the Bureau of Mines in Rolla, Mo., can now be reached at the U. S. Vanadium Corp., Rifle, Colo.

L. A. Walker returned to Salt Lake City in March from a two-month professional trip to Colombia. Traveling to his destination in the Andes near the border of Ecuador his modes of transportation scaled from plane to auto and finally to mule. He stopped over long enough to meet members in Medellin, Cali, and Pasto.

S. Power Warren wishes to advise his friends that he has returned to Washington, D. C., after spending most of the first three months of the year studying the various mines and phosphate matrix treating plants of the

Florida field. During his stay he attended the meetings of the local phosphate group of the AIME and reports that the meetings were well attended by representatives of all the operating companies and the programs were enjoyable. His advice to the members contemplating a trip into this field is that they arrange their schedule to be there the first Monday of the month because at no other time will so many members be available in one place.

Donald R. Wells, of 153 Fallis Rd., Columbus 2, Ohio, is employed at Battelle Memorial Institute as a laboratory technician in the electron microscopy division.

Richard H. Wesley, with his two partners, after several years' study of the field, have gone into the consulting geological engineering business as Wesley, Bedford and Stickel, 2370 Penobscot Bldg., Detroit 26, Mich. Mr. Wesley writes: "We are in a position to carry on any type of exploration work any place in the world. This includes airborne geophysical work. Our laboratories are equipped for analyses of mining, petroleum products, and complete studies in soil mechanics. We can carry on spectrographic, petrographic, and core testing analyses. Our activities are not only confined to mining and petroleum, but also embrace preliminary studies for any major civil engineering project."

Joseph L. Walker, Jr., holds down the job of research mining engineer with the Rimersburg Coal Co., Rimersburg, Pa.

Robert Weagel, formerly shift foreman of the U. S. Section of the **U. S.** Smelting Refining and Mining Co., was appointed assistant general mine foreman of the section on Feb. 1.

J. P. Weir received the degree of bachelor of science in mining engineering at the midwinter commencement exercises of the Pennsylvania State College. At the same exercises, the technical degree, engineer of mines, was conferred upon his father, **Paul Weir.** Mr. Weir is now associated with his father in his consulting mining engineering firm, the Paul Weir Co.

Henry P. Whaley has the job of testing engineer with the Erie Mining Co., Hibbing, Minn.

A. D. Wilks was appointed superintendent of the Ordnance Factory, Katni (C.P.) India, over a year ago.

James W. Wivell has joined the staff at the Embarrass iron mine of Pickands Mather & Co.

Edward H. Snyder, president of the Combined Metals Reduction Co., Salt Lake City, was elected president of the American Zinc Institute at the annual

H. I. Young shows his successor as president, E. H. Snyder, a clock given him by the institute in token of his long service.

meeting of the board of directors, succeeding **Howard I. Young,** who has held the office since 1935. New vice-presidents include **George Mixter,** vice-president of the U. S. Smelting Refining and Mining Co., Boston, and **Raymond F. Orr,** president and general manager of the Athletic Mining and Smelting Co., Ft. Smith, Ark. **Erle V. Daveler,** vice-president of the American Zinc, Lead and Smelting Co., New York City, was elected treasurer and **Ernest V. Gent** was reelected executive vice-president and secretary. To serve as directors until 1952 are **A. E. Bendelari, O. W. Bilharz, C. M. Chapin, Jr.,** and **S. H. Levison.**

L. E. Young visited the McLeod River property of Canadian Collieries (Dunsmuir) Ltd., Nanaimo, B. C., the first week in April, thence proceeding to the Vancouver Island headquarters of the Company for an inspection of properties and consultation with **H. R. Plommer,** managing director.

• In the Metals Divisions

Paul H. Anderson received his M.S. degree on March 17 from the University of Minnesota, where he majored in metallography, and minored in industrial engineering. The title of his thesis is "Hot Dip Tinning of Low Carbon Steels." He intends to remain at the university to work toward a Ph.D. degree.

Bernhard Blumenthal, formerly research metallurgist with the American Platinum Works, Newark, N. J., has joined the staff of the Argonne National Laboratory, Chicago, Ill., as an associate metallurgist.

Chester L. Brown can now be reached at the production division of the development and research department of the Continental Oil Co., Ponca City, Okla.

D. S. Cameron has been made open hearth superintendent of the Wickwire Spencer Steel Division of the Colorado Fuel and Iron Corp. Buffalo plant.

Harry A. Campbell, executive engineer for Fredric Flader, Inc., manufacturer of gas turbines, receives mail at 341 Goundry St., Apt. 4, N. Tonawanda, N. Y.

Gregory J. Comstock, director of research of the powder metallurgy laboratory at Stevens Institute of Technology, left on April 5 by military transport for a month's stay in England, Germany, and Austria, on a commission for the Bureau of Ships of the U. S. Navy Department. The purpose of the visit was to discuss parallel research projects with British Governmental agencies. He visited the Edelstahlwerke and Verienegeste-Stahlwerke plants in Germany to study the current industrial application of chromizing. During the recent war, Professor Comstock served in Germany for the U. S. Joint Chiefs of Staff. Returning to this country, he was connected with the FEA and later with the U. S. Department of Commerce. Professor Comstock, on the Stevens staff since 1939, occupies the first chair of powder metallurgy established in any institution of learning in the States.

Minu N. Dastur has the job of metallurgical staff assistant with H. A. Brassert & Co., New York City.

Robert B. Day, now with the Linde Air Products Co., New York City, is in the Company's cylinder inspection and maintenance department as inspector for purchasing of pressure vessels.

Gerhard Derge and **Frederick N. Rhines** have been appointed to full professorships in the department of metallurgical engineering, college of engineering and science at Carnegie Institute of Technology effective Sept. 1. Both men joined the Carnegie staff in 1934. Dr. Derge, who graduated from Amherst and received his Ph.D. from Princeton, is a member of the Electric Furnace Steel Conference Committee of the Iron and Steel Division, AIME. Dr. Rhines, a Michigan and Yale graduate, is the Aluminum Co. of America professor of light metals and a two-time winner of the Institute of Metals award.

Denton T. Doll joined the staff of the chemistry and metallurgy division of the University of California Los Alamos Scientific Laboratory on April 11. He had been with the Brush Beryllium Co. in Cleveland.

Kenneth L. Erickson is employed as a chemist in process research by the Basic Reduction Co., Henderson, Nev.

Clyde R. Tipton, Jr.

Clyde R. Tipton, Jr., joined the staff of the chemistry and metallurgy division of the Los Alamos Scientific Laboratory, P. O. Box 1663, Los Alamos, N. Mex. He had been with Battelle Memorial Institute.

R. R. Estill has been made general superintendent of the fluorspar division of the U. S. Coal and Coke Co. at Mexico, Ky., replacing **K. A. Johnston,** who was transferred to the construction division at Lynch, Ky., on March 15.

J. Leon Gittlen is president and production manager of the Consumers Metal Corp., smelters and refiners of metals, Detroit.

Lawrence G. Glasglow, although still employed in the materials laboratories of Chance Vought Aircraft, is reached now at 1113 Canterbury Ct., Dallas, Texas, since the company has moved from Stratford to Dallas.

Richard A. Gorski is foreman relief trainee in the blast furnace division of the Gary works of the Carnegie-Illinois Steel Corp. His address is 4447 Grant St., Gary, Ind.

Charles H. Homer, Jr., formerly plant superintendent of the Beaumont Iron Works Co. at Beaumont, Texas, has been transferred to the Dunkirk, N. Y., plant of the parent organization, American Locomotive Co., Alco products division, where he assumes the duties of chief quality control engineer. The Dunkirk plant produces heat exchangers, pressure vessels, prefabricated pipe, large diameter pipe and other equipment for the petroleum, chemical, and allied industries. Mr. Homer's new mailing address is 353 Temple St., Fredonia, N. Y.

Carl H. Himmelman is a supervisory trainee with the Timken Roller Bearing Co. at Canton, Ohio.

Harry K. Ihrig, vice-president and director of laboratories of the Globe Steel Tubes Co., Milwaukee, Wis., received a citation for distinguished service in engineering from the College of Engineering of the University of Wisconsin at Madison on March 15.

Paul Linz resigned as a partner of Carl M. Loeb, Rhoades & Co. effective April 30, to become personal assistant to Dr. Mauricio Hochschild in all enterprises with which he is connected.

Roger D. Moeller joined the staff of the chemistry and metallugy division of the University of California Los Alamos Scientific Laboratory on March 21. He had been with the Sharples Corp. research laboratory in Philadelphia.

Claude R. Monlux graduated from Yale in February and is now employed in a training capacity by the Ohio Steel Foundry Co. of Springfield, Ohio.

Norman F. Tisdale

Norman F. Tisdale, chief metallurgical engineer of the Molybdenum Corp. of America since 1933, has been made manager of sales. A native Canadian and graduate of Queen's University, Kingston, Ont., he is well known in the iron and steel industry.

David P. Moore, of 68 Muskoka Rd., Grosse Pointe Farms 30, Mich., is metallurgist for the Hudson Motor Car Co., Detroit, Mich.

Thomas C. Nelson, Jr., is metallurgist for the General Electric Co. at the Hanford works in Richland, Wash.

William H. Nikola, who lives at 83 Highland Ave., Jersey City, N. J., is quality control engineer for the Westinghouse Electric Corp.

Leon V. Omelka is working as testing engineer for the Permanente Metals Corp., Trentwood, Wash. His mail goes to S. 4114 Ivory, Spokane, Wash.

Joseph R. Patterson, Jr., is at 468 Market St., Beaver, Pa., working for the Babcock and Wilcox Tube Co.

Burton C. Person, of 315 St. Louis St., Baton Rouge, La., is metallurgist in the Louisiana division of the Esso Standard Oil Co.

Fred P. Peters, editor-in-chief of *Materials & Methods,* has been made vice-president and publishing director of the book division of the Reinhold Publishing Corp., New York City 18.

Chester F. Robards is research metallurgical engineer on aircraft engines at the NACA Lewis Flight Propulsion Laboratory, Cleveland. He lives at 14029 Gramatan Ave., Cleveland 11, Ohio.

Leonard W. Rothe is a metallurgical trainee with the Armco Steel Corp., Middletown, Ohio. His home address is 2205 Lamberton St., Middletown.

Philip S. Savage, Jr., is working for the McCallum Bronze Co., Buffalo, N. Y. His address there is 242 4th St.

Arthur B. Shuck, formerly a research metallurgist with the metal products division of the Koppers Co., is now in the metallurgical section of the Argonne National Laboratory.

John A. Swift has formed the Swift Industrial Chemical Co., Hartford 1, Conn., to manufacture a complete line of chemical and metallurgical materials for metal cleaning, blackening, and heat treating. Mr. Swift has had extensive experience in the metal manufacturing, fabricating, and processing industries, having done work for the Western Electric Co., the American Steel and Wire Co., the Billings and Spencer Co., and the Heatbath Corp. In addition to his industrial experience, he has organized and instructed various metallurgical courses for evening divisions of the Hillyer College, New Haven Junior College, and the University of Connecticut. A registered metallurgical engineer in Connecticut, he is also engaged in consulting on heat treating, testing, surface finishing and treating, and fabricating of metals and metal products. Recently he served on the New England AIME Committee for the 1949 Regional Conference held in Springfield, Mass.

J. D. Swindale has left the Mond Nickel Co. and has resumed his war-interrupted studies at Birmingham University, Edglaston, Birmingham 15, England.

E. T. Turkdogan was recently awarded the degree of Master of Metallurgy in recognition of his research work on slag metal reactions at the University of Sheffield, Sheffield, England.

Joe G. Uzelac, formerly a student at the University of Utah, is working for the Denver Equipment Co., Denver, Colo., as a metallurgical engineer.

Ralph L. Wilcox, metallurgical engineer and vice-president of the Gerity-Michigan Corp., is now serving on loan from his company as chief of the nonferrous metals branch of the ECA in Washington, D. C. Mr. Wilcox says he would welcome a visit from any of his old WPB friends.

Tzuliang Wu is research engineer at the Institute of Industrial Research, Syracuse University, Syracuse, N. Y.

• In Petroleum Circles

Bernard W. Allen, former Colorado School of Mines student, has become a petroleum engineer with the Ohio Oil Co., Box 530, Cody, Wyo.

Joseph A. Buland, Jr., is currently employed by the Baroid Sales Division of the National Lead Co. as drilling mud service engineer in southwestern Wyoming. His mailing address is in care of the Teton Hotel, Riverton, Wyo.

John H. Dante is geologist and production manager with F. G. Fox and W. J. Fox of Owensboro, Ky. His address there is 829 Griffith Ave.

Harry Dereniuk, formerly with the Republic National Gas Co., is now with the Conroe Drilling Co., Corpus Christi, Texas, as a petroleum engineer.

Hal B. Fullerton, Jr., is an engineer in training with The Texas Co. at Long Beach, Calif. He lives at 336 Prospect Ave., Long Beach.

James R. Graham, after graduating from Louisiana State in January, accepted a job as petroleum engineer with the Standard Oil Co. of Texas. At present he is located in the Western division office in Midland, Texas.

Edward A. Gribi, Jr., finished his studies at Stanford last December and has been employed as a geologist by the Sinclair Petroleum Co. for exploration work in Ethiopia.

John J. Jakosky, Jr., is engineer with International Geophysics Inc., 1063 Gayley Ave., Los Angeles 24.

Robert Kamon, former University of Texas student, is a junior partner in the firm, Kamon Petroleum Exploration, Cisco, Texas.

W. D. Beach

W. D. Beach, petroleum engineer with the Gulf Oil Corp., recently joined the reservoir section of the executive department in Houston, Texas. He was formerly with the Gulf production division of the Gulf Refining Co. at Laurel, Miss. Mr. Beach is a Penn State graduate and served as secretary-treasurer of the Mississippi Subsection of the Delta Section, AIME, for the last half of 1948.

Julie Anne Klovstad

Julie Anne Klovstad, formerly geologist with the Shell Oil Co. at Jackson, Miss., is now doing consulting work in eastern Colorado as well as working toward a Ph.D. degree at the University of Colorado. She may be reached at 1135 University Ave., Boulder.

Philip Kraft resigned as a director of the Magma Copper Co. last December 15.

Frank E. Long graduated from the University of Oklahoma with a degree in petroleum engineering and at present is employed by the Magnolia Petroleum Co. as an engineer trainee. His address is General Delivery, Falfurrias, Texas.

Charles T. McClure, formerly with the Signal Oil and Gas Co., has become associated with the Youngstown Sheet and Tube Co., Los Angeles, as a field engineer.

R. B. Luke McCullar, who is sales engineer for the Western Co., can be reached at Box 310, Midland, Texas.

Kenneth E. Meyer, petroleum engineer with the Cities Service Co., New York City, has been transferred to the Gulf Coast division. His new address is 1440 Mellie Esperson Bldg., Houston 2, Texas.

James I. Morris is working for the Pure Oil Co. as district production engineer. Mail reaches him at Box 700, Worland, Wyo.

Harold L. Patterson is in Delmita, Texas, working for the Sun Oil Co. as a petroleum engineer.

Warren D. Phelps, who had been at Texas A&M, is working for the Magnolia Petroleum Co., Box 792, Drumright, Okla.

Edward W. Racek, former University of Tulsa student, has the job of petroleum engineer for the Acme Well Supply Co., New York City. His home is at 36 Dogwood Lane, Levittown, Hicksville, N. Y.

Leslie B. Riggins, Jr., is chief engineer and geologist for the Portable Drilling Corp. His mail goes in care of the Company to P. O. Box 1318, Seminole, Okla.

John L. Ross is student engineer in the Gypsy division of the Gulf Oil Corp., Tulsa, but gets his mail at 112 N. Maiden St., Waynesburg, Pa.

E. S. Rugg can be reached in care of The Texas Co., New Castle, Wyo., where he is an engineer trainee.

Irl Sandidge, Jr., formerly with the Ohio Fuel Gas Co., Columbus, is now addressed at the United Fuel Gas Co., Box 1273, Charleston 25, W. Va.

W. S. Skinner received an M.S. degree in geology from Lehigh last June and during the summer worked for the New York State Science Survey to finish an investigation of oil possibilities in Otsego County, N. Y., which was begun in the summer of 1947. Last October he took the job of geologist with the South Penn Oil Co., Parkersburg, W. Va.

N. A. Tinker, Jr.

N. A. Tinker, Jr., joined the consulting engineering and geological firm of DeGolyer, MacNaughton & Murrell, Dallas, on March 15. While in Tulsa, before taking this latest post, he was sales contact engineer for the Weatherford Oil Tool Co., and prior to that was with the Gulf Oil Corp. as North Texas zone engineer.

Carle F. Sharp, Jr., formerly a student at the University of Texas, is working as a junior reservoir engineer for the Humble Oil and Refining Co. His mail goes to Box 357, Katy, Texas.

Duncan M. Smith, Jr., is now associated with the California Co. at the Lake St. John field at Waterproof, La.

Henry J. Stewart, now with the Union Oil Co. of California, P. O. Box 1365, Orcutt, Calif., used to be with the Sunray Oil Corp. in Alice, Texas.

Reid T. Stone is assistant field engineer for the Axelson Mfg. Co., Huntington Park, Calif. He lives in Apt. B, 8655 California Ave., Southgate, Calif.

H. J. Struth, former editor of the Petroleum Data Book, can now be reached in New York City at the American Petroleum Institute, Dept. of Information, 50 W. 50th St.

Ralph E. Taylor, who was with the Freeport Sulphur Co., joined the staff of Humble Oil and Refining Co. on March 15. He is addressed in care of the Company, Box 2180, Houston 1, Texas.

J. U. Teague resigned as superintendent of the Hogg Oil Co. on Feb. 1 to assume the presidency of the Columbia Drilling Co. This concern is engaged in the contract drilling of oil wells and maintains an office at 2011 Niels Esperson Bldg., Houston, with a field office and storage yard at West Columbia, Texas. Mr. Teague entered the oil business upon graduation from Rice Institute nineteen years ago as a petroleum engineer with the Humble Oil and Refining Co. He resigned in 1940 to become general superintendent of the Hogg Oil Co., interrupting this job with three years as a Lieutenant Commander in the Navy; he came out of service with seven battle stars in the Pacific theater. The Teagues live at 2406 Dorrington, Houston.

John F. Truchot, Jr., is working for the Rocky Mountain division of the Stanolind Oil and Gas Co. as a geologist. His address is P. O. Box 40, Casper, Wyo.

J. H. Van Zant is vice-president of the Van-Grisso Oil Co., 1414 Fort Worth National Bank Bldg., Fort Worth 2, Texas.

W. Frank West is a petroleum-engineer trainee with the Continental Oil Co., P. O. Box 451, Ventura, Calif.

Obituaries

Sydney Hobart Ball

AN APPRECIATION BY DONALD M. LIDDELL

Sydney H. Ball, a member of the Institute for 42 years, and Director from 1924 to 1927, died of a heart attack on Friday, March 25, at his home in New York City, aged 71 years and three months. He was active until the last, having been on professional work in British Columbia in December, when he had the first attack of his fatal illness.

Born in Chicago, he received in 1901 an A.B. degree from the University of Wisconsin, which awarded him a Ph.D. in 1910. He was one of the few who came into prominence in his youth. Having worked for the U. S. Geological Survey from 1903 to 1907, he was asked in the latter year to head an expedition to examine the concession of the Société International Forestiere et Miniere du Congo for the Ryan-Guggenheim group. Three years of work firmly established his reputation as an able field geologist and executive. It is probable that the Congo-Angola diamond field, an outgrowth of this expedition, is the richest known. From that time on, his services were in demand in every part of the world. From 1917 until his death he was associated with the firm of Rogers, Mayer and Ball, of which he was the last survivor.

He was three times decorated by the Belgian Government, first as Chevalier de l'Ordre Royal du Lion; second as Officier de l'Ordre Royal du Lion; and finally in January of last year, Commandeur de l'Ordre de Leopold II, the highest Belgian decoration that can be given a civilian.

For many years he had contributed the annual articles on gemstones to the Bureau of Mines Minerals Year Book, and had written for various trade publications. He was a member of the New York Jewelers' Publicity Committee and was largely responsible for the House of Jewelers at the New York World's Fair. A study that the writer found hugely entertaining embodied a long research into the use of gemstones by the Pre-Columbian Indians of the Americas.

In pure geology he made his mark by a study of Tertiary dikes and Pleistocene glacial deposits, which established the existence of two distinct ages in the so-called Front Range. He carried out the first accurate mapping of Death Valley, Calif., about 1907.

Known to the engineers and geologists of the world by reputation, his personality endeared him to his associates here. He was a charter member and later president of the Mining Club of New York City. He had been a member of the Mining and Metallurgical Society of America for 37 years and was its president in 1933. He was president in 1930 of the Society of Economic Geologists, and an honorary member of the Gemological Institute of America and of the Chemical, Mining and Metallurgical Society of South Africa. He was a member and one-time governor of the Explorers Club, and a director of the CRB educational fund.

One can give only a bare outline of his long and busy life. One cannot put on paper a proper appreciation of his serious conversation or of his impish delight in jokes on those he knew well. Nor can one express an adequate acknowledgment of his readiness to put his knowledge at the service of his friends.

ELWOOD BACHMAN (Member 1940), who was recently engaged in the electrification of the Utah Copper Company's Bingham property, and who had been associated with the General Electric Co. since 1916, died last Dec. 16. A man of many talents and interests, Mr. Bachman, when he received his E.E. degree from the University of Utah in 1916, already had three years of mine electrification, railway construction, and test work behind him. After joining General Electric he worked on mine in-

stallations, mill electrification, and electrolytic investigation projects, was at the same time in complete charge of electrical engineering at the Flin Flon plant of the Hudson Bay Mining and Smelting Co. in Hudson Bay.

LEGRANDE D. BARRETT (Member 1939), mining engineer, is dead. Mr. Barrett died at the age of 33 in South Africa, while acting as a Mormon missionary there. He had resigned, in 1946, his job as acting branch manager for the Salt Lake City office of the Independent Pneumatic Tool Co., in order to go on the mission. After receiving his B.S. in mining engineering from the University of Utah in 1941, Mr. Barrett worked for the Kennecott Copper Co., and then as an engineer for the New Park Mining Co., at Keetley, Utah, before taking his last professional job in 1944.

ARTHUR J. BOASE (Member 1936), former college professor and most recently manager of the Portland Cement Association's structural and technical bureau in Chicago, died recently. Before entering the University of Colorado in 1915, Mr. Boase had been superintendent of construction for the Boston Colorado Power Co. in Denver, and then assistant city engineer at Boulder. From 1920 to 1921 he studied at the University of Pennsylvania, and during those years and for three years thereafter was an instructor in civil engineering at that school. He then headed the department of civil engineering at Pennsylvania Military College for six years before joining the Portland Cement Association.

CHARLES EDWARD BRUFF (Member 1920), died in Berkeley, Calif., on Feb. 25 at the age of 72. He had been San Francisco representative for the Stevens Adamson Co. until his retirement several years ago.

It was 1895 when Mr. Bruff graduated from Purdue University with his degree in engineering, and for the ensuing fifteen years he was a drattsman for the L. C. Trent Co., assistant manager for the Bradley Engineering and Machinery Co., and a representative of the Power and Mining Machinery Co. in New York. Then he went on in 1910 to build the Chino mill in Hurley, N. Mex., and journeyed to Alaska to supervise construction of the Gastneau mill in Juneau, both assignments under the aegis of the D. C. Jackling engineering firm. After 1915 he was a partner in the Bradley, Bruff and Labarthe organization, actively engaged in the construction of the Alaska Juneau mill and the building of many domestic and foreign metallurgical plants.

EDWARD E. BUGBEE (Member 1905), nationally known for his work in mining and metallurgical engineering, and a professor emeritus at MIT, died suddenly in Boston, Mass., on Feb. 2, at the age of 72. Professor Bugbee graduated from MIT in 1900 and began his career as an instructor in that school's metallurgical laboratory the same year. In 1903 he was made an assistant professor at Iowa State College, but later returned to MIT, retiring as an associate professor of mining engineering and metallurgy in 1941.

LUCIUS A. BUTLER (Member 1920), died, at the age of 60, on Jan. 23. His last professional association had been with the U. S. Engineering Department in San Francisco. Mr. Butler was a graduate of the Michigan College of Mines, and spent the early years of his career with mining companies in Canada, Minnesota, and Michigan. He worked with the Inland Steel Co. for three years, and then became a project engineer with the Michigan State Highway department. In 1938 he joined the engineering corps of the War Department, working in his native Michigan until he moved to San Francisco.

FOREST L. CAMPBELL (Member 1940), chief engineer for the exploitation department, southern division, of Richfield Oil Co., died on Jan. 11 in Long Beach, Calif., of a heart attack. The 51 year old engineer's career began in 1918 with the San Dimas Co., in Mexico. He received an A.B. degree from the University of California in 1921, spent five years with the oil and gas division and State Mining Bureau of California, and joined the Richfield Co. in 1928, as a resident engineer. Mr. Campbell's chief interest was in petroleum, although mining geology and mining and milling also fell within the scope of his many abilities.

MARK G. CARHART (Member 1943), died on March 6 at the age of 66. Thus was ended an amazingly versatile career which created a man with broad managerial and engineering talents. At the turn of the century, Mr. Carhart was a young farm worker. A year later he was managing a lighting and water plant in Bartow, Fla.—and so it went through the first two decades—a continued eclectic interest in public power and private industry, from sales, production, and engineering viewpoints. The year 1930 found him managing the Venezuela Power Co. at Maracaibo. He was no stranger to Latin America, having served for the previous three years as chief engineer for the Westinghouse Corp. in Mexico City.

From 1931 to 1941 he represented Canadian mining operators in New York, developing finances and supervising hard rock mining operations in gold, silver, and copper ores. It has been said that Mr. Carhart's career was truly representative of the fast-disappearing tradition of our industrial leaders who made their own careers from the rich clay of experience.

Cassius I. Cook

AN APPRECIATION BY W. J. COULTER

In the passing of Cassius I. Cook, general manager of the Consolidated Coppermines at Kimberly, Nev., on Dec. 22, the mining fraternity lost a well known friend in the industry. For many years Mr. Cook had suffered from an asthmatic condition and his death was attributed to complications resulting from an acute condition.

Mr. Cook was born near Portland, Oreg., June 18, 1886. He received his early education in Boise, Idaho, and graduated from the University of Idaho in 1911. In college Mr. Cook took an active part in athletics and for three years played on the football team.

After graduating from the University of Idaho, he became superintendent of the Silver City Mining and Milling Co., at Silver City, Idaho. From Silver City he went to Alaska in 1915 and later to British Columbia where he was employed by the Granby Consolidated Mining, Smelting and Power Co. In 1927 Mr. Cook left Anyox, B. C., where he was assistant mine superintendent, to accept a position as mine superintendent of Consolidated Coppermines. During the depression period, from 1932 to 1935 when Coppermines was closed down, he operated a small gold property in Grass Valley, Calif. In 1935 he went to Silverton, Colo., where he was general superintendent of the Shenandoah Dives Mining Co. until 1940 at which time he returned to Kimberly, Nev., as general manager of the Consolidated Coppermines, which position he held at the time of his death.

Mr. Cook was well known and had many friends in the mining field. He was an active member of the American Mining Congress, AIME, Colorado Mining Association, a director of the Nevada Mine Operators Association and a member of the Ely Rotary Club. Mr. Cook was also a member of the Kappa Sigma Fraternity.

The news of Mr. Cook's death comes as a shock to his many friends in the mining industry and to all who knew him.

HERSCHEL E. DENTON (Member 1946), managing director of General Petroleums Ltd., and a partner in the firm of Denton and Spencer since 1941, died on March 30 in Calgary, Alta. He was 41. Mr. Denton had a B.S. in mechanical engineering, which he achieved by alternate years of work with the Casper Oil Co. of Wyoming and attendance at New Mexico A&M. By 1938, he was production superintendent for the Anglo-Canadian Oil Co. in Calgary, and three years later joined the two firms with which he was associated until his death.

Howard Drullard

AN APPRECIATION BY HARVEY G. BOSTICK

Our AIME Directory notes: Drullard, Howard (Member '18) Min. Engr., Min. Machinery, 1026 Folsom St., San Francisco, Calif. Howard was proud of the AIME and his San Francisco Section affiliation.

He passed away in San Francisco on Jan. 29, of a heart attack. He was born in Buffalo, N. Y., in 1883, and attended private schools. He had a desire for mining and so became a shifter in the Second St. tunnel in Los Angeles and in the Elizabeth Lake tunnel of the Los Angeles water department. He contracted in the Ray Con. in Arizona, and subsequently managed the Hardenburg and Poundstone mines in California's Mother Lode. He also mined in Mexico and Central America.

While still a young man Howard was the victim of a blasting accident. Fortunately he pulled through with half vision in one eye. He never accepted this as handicap and this was evidenced by the fact that during the 1915 San Francisco exposition and fair, he represented five companies. Denver Rock Drill Co. was one of them, and after the closing of the Fair, Howard became affiliated with it. He was in turn Butte, Mont., manager, Salt Lake City manager, and then a representative for Gardner-Denver in Japan and Korea. Returning to the States in 1928, he attended Stanford University. In 1932 he decided to enter private business and established the firm which he managed until his demise.

This is an example of Howard's great human kindness and understanding: During his residence in Butte he became acquainted with Stephen Breckenridge, a miner totally blinded by an explosion. Encouraged by Howard to "carry on," Steve sold newspapers. Later, Steve moved to Los Angeles and has been on the corner of Fifth and Broadway for many years—selling newspapers—and is independent. Howard never failed to visit Steve during his Los Angeles calls.

Howard Drullard's counsel was kindly. His many, many friends all over the world will be saddened by his passing, but he was the type of man that will live on in memory and in spirit.

CECIL DRAKE (Member 1931), died in Taft, Calif., on Jan. 31, at the age of 49. He had worked for the Standard Oil Co. of California since 1946. With an E.M. in geology from the Colorado School of Mines, Mr. Drake went to Mexico in 1922 to work for the Eagle Petroleum Co. of Mexico, a Shell company, and remained there for eight years. Then he returned to the States to work for the Shell organization in Illinois and Oklahoma before joining Standard Oil.

Donald R. Knowlton

DONALD R. KNOWLTON (Member 1932), manager of the foreign department of the Phillips Petroleum Co., and perhaps best known for his work as director of production with the Petroleum Administration for War, died in Oklahoma City on March 9 after a short illness. He was 54. After taking his E.M. degree from Stanford University in 1924, Mr. Knowlton worked as an engineer for the Continental Oil Co. in Texas, joined the Phillips organization in 1930, becoming chief production engineer a year later. He recently stirred the business world with a magazine article on "The Semantics of Financial Reports" which censured the obscure, technical language in which financial reports are phrased.

LIONEL H. DUSCHAK (Member, 1917), professor of metallurgy at the University of California, died on Nov. 27. Born in 1882, Dr. Duschak received his A.B. degree from the University of Michigan in 1904, went on to take an M.A. and Ph.D. from Princeton four years later. With his degrees in chemistry, he taught that subject at Princeton from 1907 to 1909, then served four years as a research engineer for the Corning Glass Works and the next five years as a chemical engineer with the Bureau of Mines. Since 1921 he had been a consulting engineer, and in 1938 joined the faculty of the University of California.

CHARLES DENHAM GRIER (Member 1915), died on Dec. 2 in Johannesburg, South Africa, where he had been, since 1923, managing director of South African Cyanamid Ltd. Born in 1889 in Denver, Colo., Mr. Grier was a graduate of the Colorado School of Mines, also had an M.Sc. degree from the University of Washington. His early experience took him through the West, and then up to Alaska. The first World War found him a Second Lieutenant in the engineers. In 1922 Mr. Grier joined the American Cyanamid Co., and the following year took up residence in South Africa to manage that Company's interests there. In 1937 he took over the position he held at the time of his death. Although his main efforts dealt with cyanide production, Mr. Grier took an active interest in the whole mining and industrial development of southern Africa.

HORACE S. GULICK (Member 1916), whose career had taken him from Oklahoma A&M to the first vice-presidency of the New York Air Brake Co., died on Jan. 31 at the age of 63. Mr. Gulick received his B.S. degree from the above-named school in 1903, and within ten years had become chief chemist for the American Steel Foundries in East St. Louis, Ill. Later he was superintendent of testing and inspection at the More-Jones Brass and Metal Co., and in 1921 superintended the Ohio Brass Company's Mansfield, Ohio, plant. Six years later he assumed a similar position with New York Air Brake, remaining with the Company until his death.

ELWIN B. HALL (Member 1914), petroleum engineer and oil geologist, died in Los Angeles on Jan. 20. Mr. Hall was 57 and had been ill for three weeks prior to his death. At the time of his death he headed the E. B. Hall Co., which operated the Union Pacific oil properties at Wilmington, California. Mr. Hall was a graduate of the School of Geology of Stanford University, where he had been a three year letterman in rugby and notably proficient in other sports. He worked as a petroleum geologist for many years, and in 1937 became president of the Hall-Baker Co. in Los Angeles.

PHILIP H. HOLDSWORTH (Member 1938), for many years prominent in Oregon mining, died at his home in Seattle last Nov. 21. He was born in 1881. Back in 1908 Mr. Holdsworth was assistant superintendent for the Alaska Smelting and Refining Co. in Hadley, later went on to do mining and metallurgical work in California, Oregon, and the State of Washington. Since 1920 he had been a consulting engineer with offices in Seattle, was greatly interested in geophysical work, and made several investigations in both Oregon and Washington employing resistivity methods.

FREDERIC W. JAMES (Member 1917), died last Dec. 28 at his home in Belleville, N. J., at the age of 68. He was a vice-president and engineer at the N. P. Nelson Iron Works, Inc., in Passaic, and had been associated with the firm for 27 years. Born in St. Marys, Reading, England, he came to this country at an early age, attended Trinity School, and the Columbia School of Mines. From the

Necrology

Date Elected	Name	Date of Death
1948	E. Paul Keuper	December 1948
1916	H. H. Stout	April 13, 1949
1914	A. M. Tweedy	January 1949

turn of the century until he joined the Nelson organization, Mr. James had worked for nine engineering concerns, as both draftsman and engineer. He devoted twenty years to serving the Boy Scouts in his hometown, was also a member of the National Historical Society, and a frequent contributor to various engineering publications.

OTTO G. LEICHLITER (Member 1935), president of the Mudge Oil Co. of Texas, died last Sept. 8, at the age of 63. Although his professional education in mechanical and civil engineering was not acquired formally, but in home studies, Mr. Leichliter was, at the age of 22, superintending a tunneling operation for the Gold Cup Mining and Milling Co. in Colorado. Two years later he joined the Edward W. Mudge Co., becoming general manager of four affiliated companies, and building coal mines, coke ovens, blast furnaces, and developing oil properties. By 1934 he was vice-president of the Weirton Coal Co. and Union Electric Steel Co., and also held the position he retained until the time of his death.

R. JOHN LEMMON (Member 1930), died in Nenagh, Tipperary, Eire, on Jan. 26. A British subject, born in Sussex in 1878, Mr. Lemmon traveled far and wide in pursuit of his metallurgical career. He was a chemist on the Gold Coast in 1911, at work in Korea eleven years later, and within the next seven years had been a metallurgist in Brazil, Turkey, Russia, and Bolivia. In 1938 he joined Imperial Chemical Industries, Ltd., in Liverpool, and at the time of his death was a metallurgist for the Irish Exploration Co. in Tipperary.

NORMAN MACKENZIE (Member 1943), owner of the Coleville Engineering Co., Spokane, Wash., died Dec. 8 at the age of 53. Born in Canada, Mr. Mackenzie attended Manitoba College and Manitoba University, receiving his B.Sc. degree in 1919. His education was interrupted from 1914 to 1919 while he served as Lieutenant-Captain in the Canadian Engineers during World War I, leading a tunneling company in England, France, Belgium, and Germany. Varied engineering experience in this country and Canada brought him to the formation of his own company in 1936. He engineered and designed 24 rural electrification systems, carried on extensive electrical, municipal, and mining consultation activities until the time of his death. Mr. Mackenzie was also an active member of numerous professional and social groups, including the American Legion, BPOE, and the Spokane Press Club.

F. A. G. MAXWELL (Member 1936), who spent his whole professional career in the South African gold mining industry, died in Johannesburg on Dec. 26. He was 74 years old. Mr. Maxwell, a British citizen, was born in Freemont, Neb., received his education at the Colorado School of Mines, and went to South Africa immediately after graduating in 1895. He played a large part in the foundation and development of metallurgical practice on the Rand, and was consulting metallurgist to the General Mining and Finance Corp. for the past thirty-three years.

Arthur S. Nichols

ARTHUR S. NICHOLS (Member 1936), vice-president and sales manager of the Illinois Clay Products Co. for more than 23 years, died on Feb. 18. He was 48 years old. Mr. Nichols, chairman of the AIME Committee on Ceramic Materials, and chairman of the Chicago Section in 1944, was a native Chicagoan, educated at the University of Illinois. He began his career in 1922 with the Harbison-Walker Refractories Co., then became a technical adviser to the Chicago Firebrick Co. before joining the Illinois organization.

ALEXANDER G. McGREGOR (Member 1915), died on March 4 at the age of 69. Mr. McGregor had been in London for the past twenty-two years, serving as a consulting mechanical engineer to the Chester Beatty group of mining companies. To that group, he brought a formidable reputation as a designer and builder of smelting works, mining, and metallurgical plants. Some of the plants he designed and constructed include: the International Smelting Co. plant at Miami, Ariz.; the Cerro de Pasco Copper Corp's. smelting works in Peru; the Phelps-Dodge smelting units at Douglas, Ariz.; and the Inspiration C. C. Company's leaching plant. During the recent war he was a consulting engineer to the British Ministry of Aircraft Production.

Mr. McGregor had a B.S. from the University of Montana, was the author of numerous economic articles and books, among them "The Correct Economy for the Machine Age," "Collective Bargaining and Decadence," and "End Wages Conflict."

WALTER B. MILLER (Member 1916), electrical and mining engineer of Huntington, W. Va., died last September. Mr. Miller was born in 1878, attended West Virginia University and the University of Kentucky, and spent the bulk of his early career with Kentucky and West Virginia coal companies, except for a stint with the Army engineers during World War I. More recently he had been general manager for the Kentucky King Coal Co., and his last affiliation was with the Guyen Eagle Coal Co. in Huntington.

THOMAS MacDONALD ROBERTSON (Member 1948), died last Aug. 16 at the age of 23. A native of Glasgow, Scotland, Mr. Robertson graduated from the Royal Technical College in 1945, became a research metallurgist and later assistant melting shop manager in the Clydebridge steel works. He was an associate member of the West of Scotland Iron and Steel Institute, and a student member of the Institute of Metals.

THEODORE W. ROBINSON (Member 1884), who was vice-president of the Illinois Steel Co. until 1932, died on Dec. 30. Mr. Robinson had been a member and director of various public and private organizations, including positions as trustee of Northwestern University, a director of the City National Bank and Trust Co., the Illinois Bell Telephone Co., and chairman of Ditto, Inc. He was an MIT graduate, class of 1884.

WILLIAM A. ROSE (Member 1940), well known figure in the iron mining industry, died in Santa Monica, Calif., at the age of 66. Mr. Rose had been with the Pickands-Mather Co. for nearly a half-century. Born in Rochester, he received a degree in mining engineering from the University of Minnesota in 1906, became chief engineer for the Oilver Iron Mining Co., and then went to Pickands-Mather in 1913. He was appointed chief engineer there, and later assistant general manager. After a short stint in Cleveland for the Company, he retired in January 1947, and went to live in California.

A. D. SHANKLAND (Member 1917), metallurgical engineer on the staff of the operating vice-president of Bethlehem Steel Co., died Jan. 5. Of Mr. Shankland's 57 years, 35 were spent at Bethlehem. He first joined the Company as a chemist in 1914, upon graduation from Virginia Polytechnic Institute. Subsequently, he rose through the positions of metallurgy inspector, engineer of tests, and assistant general manager, to the post he was holding at the time of his death.

FREDERICK WARREN SNOW (Member 1917), president of the Vermont Copper Co., died in Hanover, N. H., on March 7. Mr. Snow had been with the Company since 1943, having served previously as general manager of the U. S. Mining and Smelting Co's. Mic-Mac mines in Quebec, and in the same capacity for the Eustis mine in Sherbrook, Que. A graduate of the University of Utah, Mr. Snow, had also spent thirteen years with the Magma Copper Co. in Superior, Ariz., and done mining and consulting work in the West and South America.

JAMES W. STARKS (Member 1945), director of the Illinois State Mines and Minerals Department, died in Springfield on Feb. 3, just seventeen days after he had taken over the post. Union members and coal operators alike had both heartily approved of his appointment last December. For the past 27 years he had been with the Peabody Coal Co., and for eight years was a mine officer in the department he came to head. He had also served four years as mine inspector in eight different counties, bringing a background of twenty-five years' varied experience to his work for the State.

DAVID R. THOMAS (Member 1904), Canadian mining engineer, died on March 4 at the age of 73, in Toronto. The British-born Mr. Thomas received his education and early training in his homeland, came to Canada in 1899 as an engineer for the Canadian Pacific Railway. Later he spent over ten years as a mine executive in Mexico, and another decade in mining, consulting, and managerial positions in Mexico, New York, and Canada, respectively. When he retired from active practice in 1930 he was a mining consultant in Toronto.

WILLIAM G. WAGNER (Member 1920), died in London, England, on March 19 at the age of 75. Mr. Wagner was managing director of George T. Holloway and Co., of London, which firm he had been with for the past forty-one years.

BAILEY WILLIS (Member 1892), seismologist and geologist of international fame, died in Palo Alto, Calif., on Feb. 19. Dr. Willis, who had made a lifelong study of earthquakes, was also a writer, lecturer, explorer, and world traveler, and extremely active until his ninety-first, and last year. A Columbia School of Mines graduate, he began his career as a mining engineer, later worked with the USGS, did research in China for the Carnegie Institution, and exploration in Argentine. In 1915 he took over Stanford University's department of geology, was forced to retire at sixty-five, but stayed on as professor emeritus until the time of his death. Just before his death he completed the second part of his two-volume biography, entitled "Friendly China."

Proposed for Membership

Total AIME membership on April 30, 1949, was 15,566; in addition 4187 Student Associates were enrolled.

ADMISSIONS COMMITTEE

James L. Head, Chairman; Albert J. Phillips, Vice-Chairman; George B. Carless, T. B. Counselman, Ivan A. Given, George C. Heikes, Richard D. Mollison, and Philip D. Wilson.

Institute members are urged to review this list as soon as the issue is received and immediately to wire the Secretary's office, night message collect, if objection is offered to the admission of any applicant. Details of the objection should follow by air mail. The Institute desires to extend its privileges to every person to whom it can be of service but does not desire to admit persons unless they are qualified.

In the following list C/S means change of status: R, reinstatement; M, Member; J, Junior Member; AM, Associate Member; S, Student Associate; F, Junior Foreign Affiliate.

ALABAMA

Birmingham — SPARF, CHARLES ROY. (R,C/S—S-AM). Explosive serviceman, Hercules Powder Co.

ARIZONA

Klondyke—WILSON, GLEN BAYHA. (C/S—J-M). Mine superintendent, Athletic Mining Co.

Morenci—JACOBY, DWIGHT CLARK. (C/S—S-J). Hydrographic engineer, Phelps Dodge Corp., Morenci branch.

CALIFORNIA

Arcadia — DRAPER, DARRELL WELLINGTON. (M). Process service representative, Linde Air Products Co.

Bakersfield — CHRISTENSEN, JOHN ALEXANDER. (M). Geologist, British-American Oil Producing Co.

Berkeley—McCLELLAND, THOMAS HUTCHISON. (R,C/S—AM-M). Field manager, Asnazú Gold Dredging, Ltd.

Fontana — SAUSSAMAN, JOHN DANIEL. (M). Superintendent, blast furnace dept., Kaiser Co.

Los Angeles — TIPTON, KENNETH AMESTOY. (C/S—S-J). Insurance agent and broker, Kenneth E. Tipton Insurance Agency.

Maywood — BOWDEN, CARL B. (C/S—S-J). Assistant petroleum engineer, Union Oil Co. of California.

Pittsburg — CALDWELL, THOMAS EDGERTON. (M). Works metallurgist, Pittsburg works, Columbia Steel Co.

COLORADO

Cherry Hills Village — NICHOLSON, JAMES DOUGLASS. (M). General manager, The Mine & Smelter Supply Co.

Leadville — METZGER, GUINN EDWARD. (C/S—S-J). Junior metallurgist, Resurrection Mining Co.

Rangely — LEUZINGER, LESLIE ADOLPH. (C/S—S-J). Field engineer, Union Pacific Railroad Co. oil development, c/o The Texas Co.

DISTRICT OF COLUMBIA

Washington — BRABANT, PAUL HENRI. (M). Consulting engineer on Chinese mines, Pierce Management, Inc.

IDAHO

Wallace—HAALAND, OTTO ELMER. (C/S—AM-M). Mining engineer, Spokane-Idaho Mining Co. HAMILTON, WOODMAN CLARK, JR. (J). Shift boss, Day Mines, Inc.

ILLINOIS

Chicago — BIDDLE, GEORGE JOSEPH. (M). Assistant sales manager, Illinois Clay Products Co. JAIN, PADAM PRASAD. (M). Engineering supervisor, Killium & Co. SIREL, I. ALEXIS. (M). Metallurgist, Youngstown Sheet & Tube Co. SLOMER, JOSEPH J. (M). Supervisor, design-hydraulics, Goodman Mfg. Co.

Danville—MERLE, JAMES JOSEPH. (C/S—J-M). Assistant preparation manager, Ayrshire Collieries Corp.

Gillespie — HUBBART, CURTIS QUENTIN. (R,C/S—S-M). Mining engineer, Superior Coal Co.

Oakwood—MULLINS, RICHARD A. (M). Chief chemist, Ayrshire Collieries Corp.

Peoria — ANDERSON, ROBERT GRANT PHILLIP. (C/S—S-J). College graduate trainee, Caterpillar Tractor Co.

Salem—LOVE, RICHARD WILLIAM. (M). District petroleum engineer, The Texas Co. MULLINS, JESSE FRANK. (J). Petroleum engineer trainee, The Texas Co.

INDIANA

Bloomington — CALLAGHAN, EUGENE. (R,C/S—J-M). Professor of economic geology, Indiana University.

West Lafayette—HOPPE, ALBERT WILLIAM. (J). Instructor of metallurgy, Purdue University.

KENTUCKY

Benham—NEWMAN, ELMER KIMBER. (R-M). Chief engineer, International Harvester Co.

LOUISIANA

Minden — LARSON, KENNETH HENRY. (C/S—S-J). Junior computer, Stanolind Oil & Gas Co.

MASSACHUSETTS

Roslindale—PAYNTON, WILLIAM C. (C/S—S-J). Staff member of metallurgy project, MIT.

MICHIGAN

Detroit — STICKEL, JOHN FREDERICK, JR. (C/S—S-J). Geological engineer, Wesley, Bedford & Stickel.

Marquette—DeHAAS, GORDON TIFFANY. (C/S—S-J). Sales engineer, C. T. DeHaas Co.

MINNESOTA

Hibbing — McDERMOTT, WILLIAM FRANCIS. (J). Mechanical engineer, W. S. Moore Co.

Parkville—VAN EVERA, JAMES W., JR. (C/S—J-M). Chief mine engineer, Inter-State Iron Co.

MISSISSIPPI

McComb — MARTIN, WALTER OBIER. (C/S—S-M). Reservoir engineer, The Texas Co.

MISSOURI

Kirkwood — MASSMANN, ALBERT P. (M). In charge of preparation, Sinclair Coal Co. QUINN, MAURICE L. (M). Electrical engineer, Sinclair Coal Co.

St. Louis—SCALLY, JOSEPH EDWARD. (R,C/S—J-M). Vice-president, Harmony Oil Corp.

MONTANA

Cut Bank—FLUGSTAD, JOHN BUTLER. (RC/S—S-M). District engineer, The Texas Co.

NEW JERSEY

North Plainfield—COOK, CHARLES ROSCOE, JR. (C/S—S-J). Research metallurgist, Titanium Division, National Lead Co.

NEW MEXICO

Buckeye—DENSON, JACK McVAY. (C/S—S-J). Petroleum engineer trainee, The Texas Co.

Carlsbad—BINSWANGER, TOLSTOY LEO. (M). Extra supervisor, U. S. Potash Co.

Hobbs—BEARLY, MARION FRANK. (J). Student engineer, Gulf Oil Corp.

NEW YORK

Albany—BROUGHTON, JOHN GERARD. (C/S—J-M). Acting state geologist, N. Y. State Science Service.

New York — CULLITY, BERNARD DENNIS. (C/S—J-M). Scientific liaison officer, Office of Naval Research, American Embassy. JAMES, HAROLD FREDERICK. (M). Metallurgical engineer, Intsel Metals Corp. RAIKLEN, HYMAN ISAAC. (C/S—S-AM). Metallurgist, Wright Aeronautical Corp. VASSILOPOULOS, GEORGE. (C/S—S-J). Metallurgist, Wright Aeronautical Corp.

Syracuse—WU, TZU LIANG. (C/S—S-AM). Research engineer, Syracuse University.

White Plains — MULLANE, JOHN JOSEPH. (M). Production executive assistant, Standard Oil Co. (N. J.).

Yonkers—LESZYNSKI, WERNER J. (M). Editor, *Powder Metallurgy Bulletin*; member, Research staff, American Electro Metal Corp.

OHIO

Columbus—NELSON, HOWARD EDWARD. (J). Sales engineer, Jeffrey Mfg. Co.

Worthington — HALL, ALBERT M. (C/S—J-M). Metallographer-in-charge, Battelle Memorial Institute.

OKLAHOMA

Bartlesville—ALLEN, ERNEST, JR. (C/S—J-M). Reservoir engineer, Phillips Petroleum Co.

Ponca City — MESSER, ELMER S. (M). Research engineer, Continental Oil Co.

Tulsa—WHALEY, NEWTON PHILIP. (M). Consultant, Whaley Engineering Co.

OREGON

Salem—SCOTT, LEWIS EUGENE. (J). Geologist, State Highway Dept.

PENNSYLVANIA

Bethlehem—LARSON, HUGO CHRISTIAN. (M). Metallurgical engineer and secretary of Bethlehem plants committees, Bethlehem Steel Co.

Norristown — MATHEWS, DONALD R. (M). Open-hearth superintendent, Alan Wood Steel Co.

Pittsburgh — EICHELMAN, GEORGE HENRY, JR. (C/S—S-J). Intermediate metallurgist, Westinghouse Research Laboratories. SEWARD, JOHN EMRIE. (C/S—S-J). Practice engineer, Jones & Laughlin Steel Co.

State College — MELDRUM, ALAN HAYWARD. (C/S—S-M). Research assistant, Penn. State College.

SOUTH DAKOTA

Belle Fourche — ELLERMAN, OTTO MATHIAS. (R,C/S—J-M). Local manager, Wyodak Chemical Co.

TEXAS

Athens — HARGRAVE, AUSTIN JESSE. (M). District production manager, Lone Star Gas Co.

Greggton—SCHMIDT, LOREN ARNOLD. (J). Junior petroleum engineer, Stanolind Oil & Gas Co.

Houston—KINDSVATER, PAUL A. (R,C/S—S-M). District engineer, British-American Oil Producing Co. LUGOL, GILBERT M. (J). Ingenieur des Mines en Service Detache, Direction des Carburants. MENETRIER, CLAUDE F. (J). Drilling engineer, Regie Autonome des Petroles. ZWICKY, ROBERT WILLIAM. (C/S—S-J). Junior exploitation engineer, Shell Oil Co.

Kilgore—GEFFS, CHARLES RALPH. (R,C/S—S-J). Petroleum engineer, Sun Oil Co.

Longview — OKERSON, STANLEY JOHN. (J). Equipment engineer, Stanolind Oil & Gas Co.

Lubbock — CHAPIN, ESROM LON. (M). Petroleum engineer, Stanolind Oil & Gas Co. COTEY, BRADFORD J. (M). Manager, Oilwell Chemical Service Co. CROSBY, GEORGE ERNEST. (R,C/S—S-M). District engineer, Stanolind Oil & Gas Co.

Midland — DARDEN, FRANK, JR. (J). Junior petroleum engineer, Humble Oil & Refining Co. GILL, PERRY A. (M). Division superintendent, Sunray Oil Corp. MOORE, WILLIAM DAVID. (C/S—S-J). Junior petroleum engineer, Humble Oil & Refining Co. PIERCE, EDWARD JARVIS. (M). Petroleum engineer, Mid-Continent Petroleum Corp.

Odessa—MASSEY, JOHN KILBANE. (AM). General superintendent, Plastic Process Corp. PRUITT, LEE EUGENE. (M). District engineer, Sunray Oil Corp.

Pampa — THOMAS, FRANK GRAHAM. (M). District petroleum engineer, Humble Oil & Refining Co.

Snyder—SHOR, GEORGE, JR. (C/S—S-J). Seismograph party chief, Seismic Explorations, Inc.

UTAH

Midvale—SCHOLL, LESTER KEITH, (C/S—J-M). Metallurgist, U. S. Smelting Refining & Mining Co.

Salt Lake City — CROPPER, KENNETH FAY. (R,C/S—J-M). Engineer, U. S. mine, U. S. Smelting Refining and Mining Co. GODBE, MURRAY CHARLES. (C/S—S-J). Geological draftsman, American Smelting & Refining Co.

Sunnydale — HEERS, ROBERT G. (C/S—J-M). Coal mine manager, Kaiser Co.

WASHINGTON

Richland — NELSON, THOMAS C., JR. (C/S—S-J). Metallurgist, General Electric Co.

WEST VIRGINIA

Morgantown—HESS, ROBERT HAROLD. (C/S—S-J). Assistant mineralogist, West Virginia Geological Survey.

Rensford — McCORMACK, GEORGE EDWARD. (C/S—S-J). Engineer, Hatfield-Campbell Creek Coal Co.

WYOMING

Cody — EVANS, RICHARD LEWIS. (M). District reservoir engineer, Stanolind Oil & Gas Co.

Worland—MORRIS, JAMES IRVING. (C/S—S-J). District production engineer, Pure Oil Co.

ALASKA

College — MONROE, D. GILBERT. (C/S—S-J). Junior engineer, Boeing Aircraft Co.

BRITISH COLUMBIA

Vancouver—BARER, RALPH DAVID. (C/S—S-J). Instructor in physical metallurgy, University of British Columbia.

MANITOBA

Lynn Lake—MORRISON, WILLIAM FRANCIS. (M). Resident geologist, Lynn Lake property, Sherritt Gordon Mines, Ltd.

ONTARIO

St. Thomas—CLAUS, SPENCER. (J). Geologist, Oliver Iron Mining Co.

Toronto — HEWITT, DONALD FRANK. (C/S—S-J). Geologist, industrial minerals, Ontario Dept. of Mines.

QUEBEC

Arvida—GILLIS, JOHN MAURICE. (M). Supervisor, caustic plant, Aluminum Co. of Canada.

CHIHUAHUA

Chihuahua — BROWN, SEVERN PARKER. (J). Assistant geologist, American Smelting and Refining Co. NESBITT, MARTIN BECERRA. (M). General superintendent, El Potosi Mining Co. ZANGWILL, AYRTON ISRAEL. (M). Assistant superintendent, Avalos smelter, American Smelting & Refining Co.

BRAZIL

Sao Paulo—SCHMIEGELOW, EGON. (C/S—S-J). Metallurgical engineer, Cia. Brasileira de Material Ferroviano.

CHILE

Chuquicamata — HENDERSON, HARRY BACKUS. (R-M). Test engineer, Chile Exploration Co.

GOLD COAST COLONY

Accra — NICHOLLS, WILLIAM. (R-AM). Mining engineer, Consolidated African Selection Trust, Ltd.

SIERRA LEONE

Freetown — MACKENZIE, GORDON BRIAN. (M). General manager, Sierra Leone Development Co.

INDIA

Bombay—MEHTA, R. K. (M). Technical director, Kamani Metals & Alloys, Ltd. and Kamani Engineering Corp.

Kolar Gold Field—RAJAN, V. M. SUNDARA. (M). Chief assistant surveyor, Nundydroog Mines, Ltd.

QUEENSLAND

Mt. Isa—SHER, LESLIE JAMES. (M). Foreman, cottrell & baghouse, Mt. Isa Mines, Ltd.

VICTORIA

Melbourne—GLEN, MALCOLM. (M). Field engineer, North American Cyanamid, Ltd.

STUDENT ASSOCIATES

Elected May 18, 1949

Charles Orville Allen.....Univ. S. Calif.
Jerry Bob Allen.....Penn. State
Nicholas Dean Altimus.....Penn. State
Jerome Anton Andruske....Univ. Kans.
Raymond Richard Angstadt.Penn. State
Joseph S. Arnold, Jr...Univ. Pittsburgh
Harry Harper Bauer.....Penn. State
Rixford Allan Beals.....Univ. Calif.
Frank Patrick Bence.....Penn. State
Charles Richard Benson.....Ohio State
Alan M. Bieber.....Okla. A&M
Charles A. Bittmann..Bklyn. Poly. Inst.
Clarence W. Bowlby....Colo. Sch. Mines
Max Irving Brown.....La. State Univ.
Stuart S. Brown.....Melbourne Univ.
Robert Winslow Brumberg..Penn. State
Douglas F. Bulloch...Bklyn. Poly. Inst.
Jerry Dean Bullock.....La. State Univ.
Furman H. Burge, Jr..S. Dak. Sch. Mines
Robert Gustav Carlson.Bklyn. Poly. Inst.
Rodney Harvey Chow....Univ. S. Calif.
Allan Abbott Coburn.....Penn. State
Arnold Gaylord Connor.....Univ. Minn.
Charles James Conrad.....Penn. State
Allen L. Crockford.Camborne Sch. Mines
Coral Roland Dardenne..La. State Univ.
Laroy Dean, Jr. .....Univ. S. Calif.
Rafael K. De Bie...Carnegie Inst. Tech.
Kramer Richard Duhe..La. State Univ.
Frank Earl Eckert, Jr.....Penn. State
Jack Walton Edwards.Texas Tech. Coll.
John Noble Ellis.....La. State Univ.
Courtland Harold Essex. Univ. Wichita.
Charles Anthony Fabo.Univ. Pittsburgh.
Alfred Norman Fanning (Rein.)
Mo. Mines & Met.
Chester Ernest Farrow, Jr...Okla. A&M.
Robert Louis Folkman.....Cornell Univ.
William D. Fugit.....Univ. Nev.
George C. Gabel.....Penn. State
Melih Izzet Genca.....Colo. Sch. Mines
Dan Kelly Gilbert.....La. State Univ.
Donald Flatau Goldsmith.Ill. Inst. Tech.
Samuel Goodman.....Wayne Univ.
Sol Gorenbein.....CCNY
Jack Edward Haflinger.....Penn. Coll.
Jonathan H. Halsey (Rein.).Univ. Calif.
Robert L. Halvorsen.....Penn. State
Robert Kay Hansen.....Penn. State
Carl Dwayne Hanson.....Penn. State
Thomas Jakie Harp.....La. State Univ.
Francis David Hart.....Lafayette Coll.
John Edward Helm.....Univ. Wisc.
John Stewart Henkel..Melbourne Univ.
Robert A. Herstine.....Penn. State
Warren Henry Hinks, Jr....Penn. State
Leonard M. Hogan....Melbourne Univ.
Perry Lanson Holsinger....Ohio State
Robert Dillon Horst...Univ. Pittsburgh
Patrick Wendell Huber.....Penn. State
Walter Prentiss Jensen .La. State Univ.
Raymond Alvin Johnson....Univ. Utah
Ernest Allan Jonas..N. Mex. Sch. Mines
John Joseph Justen.....Univ. Tex.
Bob Kazarian.....Univ. S. Calif.
Dean David Kerr.....Univ. Kans.
John Stuart Koegle.....Ohio State
Arthur Andrew Krieger.....Univ. Nev.
Ulf S. Landergren..Carnegie Inst. Tech.
Warren E. Latimer.....Penn. State
Robert William Lawrence...Penn. State
Eric J. Layton.....Melbourne Univ.
James Clark Leisk.....La. State Univ.
Robert Vinton D. Lord, Jr....Iowa State
John Dabney Lung.....Univ. S. Calif.
Sidney Marcus.....CCNY
Roy C. Martin.....Ill. Inst. Tech.
Garrett Andrew Mayon.La. State Univ.
John Alfred McCabe.....Okla. A&M
James William McCarrick, Jr.
La. State Univ.
K. David McKay.....Melbourne Univ.
Charles Allan McLeish.....Univ. B. C.
Raymond N. McNally.Melbourne Univ.
Arthur Theodore Mengel...Penn. State
Robert J. Menzie.....Penn. State
Robert E. Merkle.....Penn. State
John Richard Miller..Mo. Mines & Met.
George Montgomery Mitchell.Penn. State
Cecil Corter Miller.....St. Louis Univ.
Fred Edward Moore.....St. Louis Univ.
Lester Lazell Neblett, Jr..Univ. S. Calif.
Carl Godfrey Nelson.....Univ. S. Calif.
Roman Nowicki.....Wayne Univ.
Paul Francis Newton....Univ. S. Calif.
Dwight Conlan Oglesbee...Univ. Kans.
Albert Fred Peterson, Jr. La State Univ.
John Anthony Potenza.....Penn. State
Gerald Edward Rennick
Univ. Pittsburgh
John Peter Rokosh.....Univ. B. C.
Ronald George Rosenkranz.Univ. Wisc.
Robert Duane Saltsman Lafayette Coll.
David Albert Sanders.....Ohio State
William Dave Sauer.....Univ. S. Calif.
John Frederick Schnars....Penn. State
Richard Joseph Schneider
La. State Univ.
Edward Stewart Shea, Jr.
La. State Univ.
William Clarence Schoof.Univ. S. Calif.
Richard Charles Sennett....Penn. State
William Harvey Shaffer.Lafayette Coll.
Keith Darden Sheppard (Rein.)
Penn. State
Clark Merrill Sherwood.....Penn. State
Robert Harvey Shrut .Univ. Pittsburgh
William Reinartz Sittig....Penn. State
Charles Eugene Sonntag, Jr.
La. State Univ.
Henry Roy Speyrer.....La. State Univ.
Henry Lee Steadman.....Penn. State
Robert Thomas Thurston.....MIT
William R. Thurtle.....Ill. Inst. Tech.
Helmuth Timm.....Univ. Okla.
George Vacek, Jr.....Ill. Inst. Tech.
Jim Wilson Vidrine.....La. State Univ.
Roland D. Wardell.....Univ. Minn.
George Patterson West.....Penn. State
Charles Campbell White.. Univ. Otago
James Leland White.....Univ. Kans.
James Ronald Williams, Jr. Penn. State
Robert Arthur Winslow.....Penn. State
H. B. Wofford.....Univ. Kans.

American Institute of Mining and Metallurgical Engineers

No Directory will be published in 1949, so the following list of AIME officers and committees is being printed in the three journals. It includes the committees of the Mineral Industry Education and Mineral Economics Divisions. Committees of other Divisions appear in Section 1 of the Branch journals as follows:

Magazine	*Division*
MINING ENGINEERING	Coal Industrial Minerals Extractive Metallurgy Minerals Beneficiation Mining, Geology and Geophysics (Not yet appointed)
JOURNAL OF METALS	Institute of Metals Iron and Steel Extractive Metallurgy
JOURNAL OF PETROLEUM TECHNOLOGY	Petroleum

OFFICERS AND DIRECTORS
1949

PRESIDENT

L. E. Young[3], Pittsburgh, Pa.

PAST PRESIDENTS

Clyde Williams[1], Columbus, Ohio
W. E. Wrather[2], Washington, D. C.

VICE-PRESIDENTS

Robert W. Thomas[1], Ray, Ariz.
C. Harry Benedict[2], Lake Linden, Mich.
D. H. McLaughlin[3], San Francisco, Calif.
A. B. Kinzel[3], New York, N. Y.
Philip Kraft[3], New York, N. Y.

VICE-PRESIDENT AND TREASURER

Andrew Fletcher[1], New York, N. Y.

DIRECTORS

Oliver Bowles[1], Washington, D. C.
Arthur J. Blair[1], Birmingham, Ala.
W. W. Mein, Sr.[1], San Francisco, Cal.
C. V. Millikan[1], Tulsa, Okla.
E. E. Schumacher[1], Murray Hill, N. J.
John R. Suman[1], Houston, Texas

Newell G. Alford[2], Pittsburgh, Pa.
Richard J. Ennis[2], Schumacher, Ont.
J. B. Haffner[2], Kellogg, Idaho
Albert J. Phillips[2], Barber, N. J.
Cresap P. Watson[2], Los Angeles, Cal.
Clyde E. Weed[2], New York, N. Y.

William E. Brewster[3], Chicago, Ill.
William J. Coulter[3], Denver, Colo.
Erle V. Daveler[3], New York, N. Y.
James L. Head[3], New York, N. Y.
W. M. Peirce[3], Palmerton, Pa.
George P. Swift[3], Waltham, Mass.

DIVISION CHAIRMEN—Directors Ex Officiis

Frederick N. Rhines (Institute of Metals), Pittsburgh, Pa.
Lloyd E. Elkins (Petroleum), Tulsa, Okla.
C. D. King (Iron and Steel), Pittsburgh, Pa.
E. R. Price (Coal), Wheelwright, Ky.
Curtis L. Wilson (Mineral Industry Education), Rolla, Mo.
Howard A. Meyerhoff (Industrial Minerals), Northampton, Mass.
S. J. Swainson (Minerals Beneficiation), Stamford, Conn.
John D. Sullivan (Extractive Metallurgy), Columbus, Ohio.
Elmer W. Pehrson (Mineral Economics), Washington, D. C.

SECRETARY

Edward H. Robie, 29 West 39th St., New York 18, N. Y.

ASSISTANT SECRETARIES

E. J. Kennedy, Jr., Ernest Kirkendall, William H. Strang

ASSISTANT TREASURER: H. A. Maloney

COUNSEL

Douglas, Armitage & Holloway, New York, N. Y.

[1] Director until Feb., 1950. [2] Director until Feb., 1951. [3] Director until Feb., 1952.

STANDING COMMITTEES
1949

EXECUTIVE COMMITTEE OF THE BOARD OF DIRECTORS

L. E. Young, Chairman
Donald H. McLaughlin, Vice-Chairman
A. B. Kinzel — Earle E. Schumacher
John R. Suman

FINANCE COMMITTEE OF THE BOARD OF DIRECTORS

Erle V. Daveler, Chairman
Philip Kraft — Clyde E. Weed

INVESTMENTS

Erle V. Daveler, Chairman
W. L. Kleitz, '52 — Henry Krumb, '50
Joseph E. Pogue, '51

Ex officiis
Andrew Fletcher, Treasurer, AIME
Erle V. Daveler, Chairman, Finance Committee, AIME

LOCAL SECTION APPROPRIATIONS

Earle E. Schumacher, Chairman
Linwood Thiessen — Clyde E. Weed

ENDOWMENT

Harvey S. Mudd, Chairman
William J. Coulter — D. C. Jackling
Cleveland E. Dodge — Milnor Roberts
H. N. Eavenson — W. A. Sinsheimer
Wilfred Sykes

ENDOWMENT FUND "X"

Andrew Fletcher, Chairman
Erle V. Daveler, '52 — Philip Kraft, '50
Franz Schneider, '51

HONORARY MEMBERSHIPS

Harvey S. Mudd, Chairman
Clyde Williams — W. E. Wrather
Henry Krumb, '50 — Leo F. Reinartz, '53
Howard C. Pyle, '51 — Reno, H. Sales, '52
L. E. Young, ex officio

ADMISSIONS

James L. Head, Chairman
Albert J. Phillips, Vice-Chairman
George B. Corless — George C. Heikes
T. B. Counselman — R. D. Mollison
R. L. Hallett — Ivan A. Given

MEMBERS' CONDUCT

Donald B. Gillies, Chairman
Eugene McAuliffe — W. E. Wrather

ROCKY MOUNTAIN INCOME

Henry Krumb, Chairman, '52
Philip Kraft, '51 — Harvey S. Mudd, '50

SEELEY W. MUDD MEMORIAL FUND

Wilber Judson, '51 — C. H. Mathewson, '49
H. DeWitt Smith, '50
L. E. Young, ex officio
E. H. Robie, ex officio

GEMMELL MEMORIAL FUND

D. C. Jackling, Chairman, '53
J. M. Boutwell, '54 — E. W. Engelmann, '50
Louis S. Cates, '52 — W. B. Heroy, '51

HENRY L. DOHERTY MEMORIAL FUND

John M. Lovejoy, Chairman
E. DeGolyer — Warren A. Sinsheimer

ROSSITER W. RAYMOND MEMORIAL AWARD

J. R. Van Pelt, Jr., Chairman, '52
N. G. Alford, '53 — C. H. Mathewson, '50
Samuel H. Dolbear, '51 — M. G. Gulley, '54
E. M. Wise, Chairman, Technical Publications Committee, ex officio

ROBERT H. RICHARDS AWARD

C. Harry Benedict, Chairman, '50
Lyle M. Barker, '51 — Ernest Klepetko, '52
Fred DeVaney, '53
C. Y. Garber, '50 — H. A. Pearse, '52
Elmer Isern, '53 — A. F. Taggart, '51
S. J. Swainson, ex-officio

RAND FOUNDATION AWARD

Zay Jeffries, Chairman

Until Feb. 1950	Until Feb. 1952
Zay Jeffries	Eugene G. Grace
David D. Moffat	Eugene Holman
Until Feb. 1951	**Until Feb. 1953**
H. N. Eavenson	S. F. Bowlby
G. M. Humphrey	W. E. Wrather

L. E. Young, ex officio

DOUGLAS METALLURGICAL MEDAL

E. W. Engelmann, Chairman

Until Feb. 1950	Until Feb. 1952
R. G. Bowman	John L. Christie
E. W. Engelmann	Elmer Isern
M. G. Fowler	E. R. Marble
R. F. Mehl	E. H. Rose
Until Feb. 1951	**Until Feb. 1953**
Ernest Klepetko	E. A. Anderson
C. H. Mathewson	H. W. Hardinge
Daniel L. Ogden	W. E. Remmers
Kent R. Van Horn	A. D. Turnbull

L. E. Young, ex officio

SAUNDERS MINING MEDAL

Fred Searls, Jr., Chairman

Until Feb. 1950	Until Feb. 1952
N. G. Alford	Earl E. Hunner
J. Murray Riddell	Albert Mendelsohn
H. L. Roscoe	Robert H. Morris
Fred Searls, Jr.	Heath Steele
Until Feb. 1951	**Until Feb. 1953**
S. S. Clarke	Jay A. Carpenter
William J. Coulter	C. Evans, Jr.
J. B. Morrow	D. D. Moffat
LeRoy Salsich	E. S. McGlone

L. E. Young, ex officio

LUCAS PETROLEUM MEDAL

Herbert Hoover, Jr., Chairman

Until Feb. 1950	Until Feb. 1952
Herbert Hoover, Jr.	A. R. Denison
James O. Lewis	M. Gordon Gulley
H. H. Power	Howard C. Pyle
Until Feb. 1951	**Until Feb. 1953**
H. F. Beardmore	J. E. Brantly
W. N. Lacey	Fred M. Nelson
Theodore E. Swigart	Wallace E. Pratt

Members ex officiis
James Boyd, Dir., U. S. Bureau of Mines
W. R. Boyd, Pres., API
Paul Weaver, Pres., AAPG
L. E. Young, Pres., AIME

ERSKINE RAMSAY MEDAL

D. L. McElroy, Chairman '50
Clayton G. Ball, '53 — C. P. Heiner, '51
W. C. Chase, '52 — C. E. Hough, '50
Evan Evans, '53 — H. M. Moses, '52
R. Y. Williams, '51
L. E. Young, ex officio

TECHNICAL PUBLICATIONS COMMITTEE

E. M. Wise, Chairman
George C. Heikes, Vice-Chairman
Gail F. Moulton, Vice-Chairman
E. J. Kennedy, Jr., Secretary

Anthony Anable — J. I. Laudermilk
Janet Z. Briggs — W. H. Loerpabel
Vinton H. Clarke — E. C. Meagher
W. H. Farrand — Earl W. Palmer
Francis B. Foley — L. C. Raymond
Gerald B. Gould — Jerome Strauss

Members ex officiis

E. H. Robie — E. O. Kirkendall
W. H. Strang

Auxiliary Publications Committees

GEOLOGY AND METAL MINING

R. A. Pallanch, Chairman

Carlos Bardwell — James R. Long
E. W. Engelmann — Whitman G. Rouillard
Ernest Klepetko — Leland A. Walker
R. S. Lewis

MINERALS BENEFICIATION DIVISION

M. D. Hassialis, Chairman

A. M. Gaudin — F. M. Lewis
Thomas M. Morris

IRON AND STEEL DIVISION

Michael Tenenbaum, Chairman

A. G. Forrest — C. S. Smith
W. E. Mahin — J. M. Stapleton
B. R. Queneau — F. M. Washburn
Otto Zmeskal

EXTRACTIVE METALLURGY

Carleton C. Long, Chairman

Hugh M. Shepard — J. D. Sullivan

INSTITUTE OF METALS DIVISION

O. B. J. Fraser, Chairman
W. C. Ellis, Vice-Chairman

H. L. Burghoff — E. H. Hollingsworth
Gerald Edmunds — G. L. Kehl
W. R. Hibbard, Jr. — R. L. Rickett

COAL DIVISION

H. P. Greenwald, Chairman

Samuel M. Cassidy — H. J. Rose
David H. Davis — G. Albert Shoemaker
Carroll F. Hardy
J. A. Younkins

PETROLEUM DIVISION

Gordon H. Fisher, Chairman

J. D. Collett, Jr. — Paschal Martin
K. C. Howard — J. A. Slicker

INDUSTRIAL MINERALS DIVISION

H. D. Keiser, Chairman

Oliver Bowles — H. I. Smith
Oliver C. Ralston — Richard W. Smith

MINERAL INDUSTRY EDUCATION DIVISION

Carl Tolman, Chairman

T. L. Joseph — H. H. Power
W. B. Plank — A. W. Schlechten

WAYS AND MEANS

Philip Kraft, Chairman
Albert J. Phillips, Vice-Chairman

N. G. Alford — Lloyd E. Elkins
A. J. Blair — H. A. Meyerhoff
W. M. Peirce

COORDINATING COMMITTEE ON TECHNICAL PROGRAM FOR THE ANNUAL MEETING

S. J. Swainson, Chairman

Charles H. Behre, Jr. — R. T. Gallagher
Philip B. Bucky — Grover Holt
W. A. Dean — T. D. Jones
H. B. Emerick — Elmer R. Kaiser
Richard M. Foose — John E. Sherbourne

STUDENT RELATIONS

M. D. Cooper, Chairman
John V. Beall, Secretary

John M. Boutwell — Donald L. Katz
R. G. Bowman — Charles E. Lawall
A. C. Callen — David R. Mitchell
Clark B. Carpenter — E. V. O'Rourke
W. H. Carson — W. B. Plank
T. G. Chapman — H. H. Power
W. R. Chedsey — E. R. Price
Carl J. Christensen — J. Murray Riddell
John S. Crout — E. F. Schramm
James R. Cudworth — H. DeWitt Smith
N. A. D'Arcy, Jr. — William I. Smyth
George H. Deike — G. R. Spindler
James D. Forrester — W. A. Staab
J. B. Haffner — J. U. Teague
E. A. Holbrook — F. A. Thomson
Charles T. Holland — S. T. Yuster

Subcommittee on Student Prize-Paper Awards

Clark B. Carpenter, Chairman

E. F. Schramm — William A. Staab

LIBRARY

Executive Committee

James Douglas, '52, Chairman
Frank T. Sisco, '50
E. H. Robie
Ex officio

General Committee

Local Section	Representative
Alaska	Earl H. Beistline
Arizona	B. S. Butler
Black Hills	Edward L. Tullis
Boston	R. Schuhmann, Jr.
Central Appalachian	Veleair C. Smith
Chicago	F. L. Riddell
Cleveland	L. W. Kempf
Colorado	J. Harlan Johnson
Columbia	Roger O. Oscarson
Delta	B. C. Craft
Detroit	D. Z. Dailey
El Paso Metals	E. M. Thomas
Gulf Coast	J. M. Bugbee
Lehigh Valley	John H. Frye
Mid-Continent	H. M. Cooley
Minnesota	W. H. Emmons
Montana	A. E. Adami
Nevada	Vincent P. Gianella
New York	Jerome Strauss
North Texas	George H. Weber
Ohio Valley	Howard Russell
Oregon	John E. Allen
Philadelphia	Charles B. Allen
Pittsburgh	G. Thiessen
St. Louis	James D. Forrester
San Francisco	George J. Young
Southeast	Russell S. Poor
Southern California	L. W. Chasteen
Southwest Texas	Ford A. Bankston
Tri-State	H. H. Utley
Upper Peninsula	Carl Brewer
Utah	R. S. Lewis
Washington, D. C.	Oliver C. Ralston
Wyoming	R. P. Hogan

RESEARCH

Elmer R. Kaiser, Chairman

R. S. Archer — Matthew A. Hunter
Fred C. Bond — Louis Jordan
P. B. Bucky — H. H. Lester
Jay A. Carpenter — C. E. MacQuigg
D. K. Crampton — Oliver C. Ralston
David H. Davis — F. H. Reed
J. E. Drapeau, Jr. — E. E. Schumacher
Gustav Egloff — H. A. Schwartz
B. E. Field — Arthur F. Taggart
A. C. Fieldner — Sam Tour
Francis B. Foley — T. H. Wickenden
Paul D. Foote — Curtis L. Wilson

COOPERATION WITH THE CANADIAN INSTITUTE OF MINING AND METALLURGY

Alan M. Bateman, Chairman
Max W. Ball, Vice-Chairman

J. A. Brusset — Philip Kraft
Roy H. Clarke — Hugh E. McKinstry
R. W. Diamond — William E. Milligan
Stanly A. Easton — Milnor Roberts
Horace J. Fraser — J. G. Ross
F. W. Guernsey — R. J. Spry
J. K. Gustafson — M. W. Summerhayes
M. L. Haider
George C. Heikes — Francis A. Thomson
Pierre R. Hines
Oliver B. Hopkins — Scott Turner
John Knox — E. A. White

PROBLEMS ARISING FROM COLLECTIVE BARGAINING

Francis B. Foley, Chairman

W. E. Brewster — Thomas G. Moore
Basil P. Kantzer — H. E. Nold
H. H. Kaveler — E. E. Schumacher
Charles R. Kuzell — Scott Turner
Frank A. Wardlaw, Jr.

SEELEY W. MUDD SERIES VOLUME ON HEALTH AND SAFETY IN MINING

Editorial Advisory Board
Clarence M. Haight, Chairman

J. J. Carrigan — H. C. Henrie
George H. Deike — Theodore Marvin
Oscar A. Glaeser — T. G. Murdock
Daniel Harrington — R. R. Sayers

SEELEY W. MUDD SERIES VOLUME ON MECHANICAL LOADING AND HAULAGE IN UNDERGROUND MINES

Editorial Advisory Board
Cadwallader Evans, Jr., Chairman

L. C. Campbell — R. E. Kirk
William J. Coulter — Eugene McAuliffe
Lucien Eaton — D. L. McElroy
R. T. Elstad — R. E. Salvati
Andrew Fletcher — Louis Ware
G. Townsend Harley — Clyde E. Weed
C. T. Hayden — L. E. Young, Editor

HENRY L. DOHERTY MEMORIAL VOLUME ON PETROLEUM CONSERVATION

Stuart E. Buckley, Chairman

C. E. Beecher — H. N. Marsh
F. DeGolyer — C. V. Millikan
R. E. Hardwicke — A. C. Rubel
W. V. Vietti

COMMITTEE ON NOMINATIONS FOR 1950 INSTITUTE OFFICERS

H. Y. Walker, Chairman

Eric R. Jette — Albert Mendelsohn

District	Section	Representative
1	Boston	Roland D. Parks
2	Philadelphia	T. T. Watson
3	New York	Thomas G. Moore
4	Cleveland	Harley C. Lee
5	Chicago	T. S. Washburn
6	Canada	R. W. Diamond
7	Black Hills	Guy N. Bjorge
8	St. Louis	J. H. Steinmesch
9	Southeast	F. H. Rose
10	North Texas	C. B. Carpenter
	Permian Basin	W. L. Crothers
11	Colorado	C. E. Dobbin
12	Montana	H. J. Rahilly
13	San Francisco	Ira B. Joralemon
14	Southern California	Henry T. Mudd
15	Carlsbad Potash	G. T. Harley

GENERAL MEMBERSHIP

C. L. Barker, Chairman
A. E. Stutter, Secretary
(Committee is composed of Chairmen of Local Section and Division Committees on Membership)

DIVISION MEMBERSHIP COMMITTEES

MINERAL INDUSTRY EDUCATION

Harry E. Krumlauf, Chairman
And the Faculty Sponsors of Student Chapters and Affiliated Student Societies

MINERALS BENEFICIATION

Nathaniel Arbiter, Chairman
James A. Barr, Jr. — J. C. Lokken
Norman L. Weiss

COAL

Curran Cavanagh, Chairman
S. J. Craighead — Charles M. Schloss
Henry A. Dierks — Fred O. See
P. H. Haskell, Jr. — Glenn E. Sorenson
Charles T. Holland — Theodore S. Spicer
Louis W. Huber — Richard H. Swallow
James Hyslop — Harold B. Wickey

INDUSTRIAL MINERALS

Richard W. Smith, Chairman
Olaf P. Jenkins, Vice-Chairman
J. A. Barr, Sr. — Henry Mulryan
Oliver Bowles — Leslie C. Richards
Edward L. Clark — Jasper L. Stuckey

EXTRACTIVE METALLURGY

Robert H. Ridgway, Chairman
Michael B. Beaver — Edward M. Tittmann
Paul C. Feddersen — Ralph H. Waddington
W. H. Goodrich — Richard A. Young
L. L. McDaniel — Stuart R. Zimmerley
R. R. McNaughton
Albert W. Schlechten

IRON AND STEEL

Norman F. Tisdale, Chairman
Worley P. Albaugh — Vernon W. Jones
Herbert J. Cutler — Charles L. Labeka
Charles H. Dewey — James Nagy
Harold B. Emerick — R. Earl Penrod
Robert B. Freeman — Harry A. Strain
John J. Golden — Bartow W. Van Voorhis, Jr.
James W. Halley — Clifton L. Wyman
Carl F. Hoffman

INSTITUTE OF METALS

Rolland Sydney French, Chairman
J. H. Scaff, Vice-Chairman
Michael B. Bever — Raymond A. Quadt
Edward J. Boyle — Stephen L. St. Jean, Jr.
Robert Maynard Brick — Clarence Arnold Siebert
H. A. Caldwell — Dana W. Smith
Carl J. Christensen — John C. Southard
John E. Dorn — Joseph W. Spretnak
L. D. Fetterolf — John E. Stukel
William J. Harris, Jr. — Lloyd George Tinkler
H. S. Jarabek
William E. Mahin

PETROLEUM

Frank Briggs, Chairman
Burton Atkinson, Vice-Chairman
Joseph H. Barnett, Vice-Chairman
Nicholas A. D'Arcy, Jr., Vice-Chairman
Vincent J. Mercier, Vice-Chairman
John K. Wright, Jr., Vice-Chairman

LOCAL SECTION MEMBERSHIP COMMITTEES

ALASKA

Harry B. Palmer, Chairman
Donald J. Cook — Bruce Ira Thomas

ARIZONA

Bruce B. Whitney, Chairman
Alfred T. Barr — C. H. Dunning
James W. Byrkit — Morris G. Fowler
B. R. Coil — Darrell Gardner
Wm. P. Crawford — Walter I. Garms
Frank H. Day — Allen D. Look
Grover J. Duff — L. L. McDaniel
Martin L. Plass

BLACK HILLS

William C. Campbell, Chairman
J. P. Gries — Arthur I. Johnson
Donald E. Moulds

BOSTON

Harrison I. Dixon, Chairman
Daniel Cushing — Roland Dane Parks
Hugh Exton McKinstry — George P. Swift
R. Maurice Tripp

CARLSBAD POTASH

Jerry E. Tong, Chairman
Walter J. Dean — Kern Smith
Charles L. Jones — William P. Wilson

CENTRAL APPALACHIAN

Veleair C. Smith, Chairman
George E. Keller

CHICAGO

William D. Millar, Jr., Chairman
Clinton Harding — Kurt Neustaetter
E. K. Miller, Jr. — Melvin E. Nickel
John H. Reese

CLEVELAND

Edward J. Vargo, Chairman
Joseph F. Cerness — John J. Vanas, Jr.

COLORADO

David P. Hale, Jr., Chairman
San Juan Subsection, Wallace G. Fetzer; Climax Subsection, John P. Hamm

COLUMBIA

Frank M. McKinley, Chairman
Rollin Farmin — Howard P. Sherman

CONNECTICUT

George F. Donahue, Chairman

DELTA

Henry M. Krause, Chairman
Ray Feirabend — H. E. Metzger
J. R. Gregson — Elmer A. Olson, Jr.
J. M. Henderson — Chas. L. Powell, Jr.
J. W. Hood — J. E. R. Sheeler
F. E. Simmons, Jr.

DETROIT

Robert N. Lynch, Chairman

EL PASO METALS

Thomas J. Woodside, Chairman
A. A. Brown — M. W. Hayward
Hugh M. Craigie — William W. Long
Philip Doerr — G. S. McKay
Earl W. Donahue — Paul A. Steger
John F. Graham — A. Joseph Yaeger

GULF COAST

Edgar A. Rassinier, Chairman
H. S. Arendt — R. P. Ridley
Herman A. Otto — Cliff W. Trice

KANSAS

P. T. Amstutz, Jr., Chairman
Ellis L. Anders — Waldo R. Warren
Carl R. Temple — P. A. Witherspoon

LEHIGH VALLEY

H. Richard Gault, Chairman
Thomas G. Foilkes — John Landon
C. Alvin Lorenson — Rodda
Edward Martinez — John Charles
A. F. Peterson — Williams

MID-CONTINENT

R. H. Gwinner, Chairman
C. B. Caruthers — Herb A. Koch

MINNESOTA

James Wilbur Van Evera, Chairman
Kenneth Duncan — R. D. Longyear
P. W. Kruse — H. M. Pickering

MONTANA

Orrin D. Weeks, Chairman
Earl M. Baldwin — Roy H. Miller
Emil S. Kramlick — Jule L. Searles
S. M. Lane — C. T. Wise

NEVADA

H. B. Chessher, Sr., Chairman
S. S. Arentz, Jr. — Charles W. Davis
Albert Silver

NEW YORK

James Douglas, Chairman

NORTH PACIFIC

Charles R. Low, Chairman
W. A. G. Bennett — Earl R. McMillan

NORTH TEXAS

Sam N. DeWitt, Chairman (Dallas)
Geo. P. Nathman — T. W. Nelson
William B. Watson, Chairman (Fort Worth)
William A. Pearce
Henry K. Hollan, Jr., Chairman (Wichita Falls)
Vassar E. Lewis — E. C. Taylor, Jr.

OHIO VALLEY

Homer Faust, Chairman

OKLAHOMA CITY

David L. Dooley, Chairman
Elmer G. Dahlgren — Martin O. Hegglund

OREGON

George C. McBride, Chairman
Fred D. Gustafson — Robert T. C. Rasmussen
James M. Orr — N. S. Wagner

PENNSYLVANIA ANTHRACITE

George A. Roos, Chairman
W. W. Everett — W. Julian Parton
George H. Holland — Walter B. Petzold

PERMIAN BASIN

Joe Chastain, Chairman

PHILADELPHIA

Ralph W. E. Leiter, Chairman
A. B. Bagsar — A. A. Bradd

PITTSBURGH

Norman F. Tisdale, Chairman

ST. LOUIS

O. M. Bishop, Chairman
George B. Clark — Drew F. Holbrook
L. P. Davidson — K. A. Johnston
M. M. Fine — Walter D. Keller
Jules C. George — Paul L. Richards
N. S. Hinchey — A. W. Schlechten
W. W. Weigel

SAN FRANCISCO

J. Ward Downey, Chairman
E. Dean Elshire — Walter L. Penick
A. A. Hoffman — Bates K. Shedd
Jack H. How — F. George Treschel
N. A. O'Donnell — George J. Young

SOUTHERN CALIFORNIA

Nichaola A. D'Arcy, Jr., Chairman

Edward D. Arthur
Carrol M. Beeson
Harold H. Block
Lawrence W. Chasteen
Irving Dagan
Seth K. Droubay
Maynard K. Drury
M. H. Evans
Keith F. Finlay
Albert W. Gentry
Walter B. Hester
William N. Hiatt
Stuart H. Ingrah
Richard H. Jahns
James A. Kavenaugh
Theodore S. Mitchel
L. A. Norman, Jr.
Kenneth B. Powell
W. A. Saylor
Richard Stewart
A. Carl Tutschulte
Walter P. Wallace
Rolla W. Walling

SOUTHWESTERN NEW MEXICO

John Gay Reilly, Chairman

Walter J. Akert
John N. Faick
Donald R. Purvis
Robert W. Shilling

SOUTHWEST TEXAS

Harold L. Moseley, Chairman

Emil F. Bowers
Barrett E. Booth
Duval A. Davidson, Jr.
J. J. Harper
Henry Hoffman, Jr.
Cecil Warden Kelley, Jr.
Edward J. Klaeger
Henry N. Lyle
Neal D. Terry
Lee J. Thronson

TRI-STATE

Ernest Blessing, Chairman

Edwin H. Crabtree, Jr.
C. E. Stover
Robert K. Stroup

UPPER PENINSULA

James S. Westwater, Chairman

Thomas M. Broderick
B. L. Knudsen

UTAH

James K. Richardson, Chairman

WASHINGTON, D. C.

Robert B. McCormick, Chairman

WYOMING

Glenn E. Sorenson, Chairman

B. W. Brown
F. H. Kratka, Jr.

1949 PROFESSIONAL DIVISIONS Officers and Committees

Mineral Industry Education Division

Established as a Division January 15, 1932

Curtis L. Wilson, Chairman

Allison Butts, Vice-Chairman

J. Donald Forrester, Secretary-Treasurer; Missouri School of Mines & Metallurgy, Rolla, Mo.

EXECUTIVE COMMITTEE

Until Feb., 1950
L. I. Cothern
Joseph Daniels
H. L. Walker

Until Feb., 1951
Clark B. Carpenter
William E. Milligan
Carl Tolman

Until Feb., 1952
R. T. Gallagher
T. L. Joseph
Ben H. Parker

J. R. Cudworth, Past-Chairman

PROGRAMS AND MEETINGS

R. T. Gallagher, Chairman

C. H. Behre, Jr.
P. B. Bucky
H. R. Hanley
H. H.Power

PUBLICATIONS

W. B. Plank, Chairman

George J. Barker
C. H. Behre, Jr.
J. W. Stewart
Harold Vance

GRADUATE STUDY

J. D. Forrester, Chairman

A. M. Gaudin
T. L. Joseph
Albert B. Stevens
Carl Tolman

OFFICIAL AIME REPRESENTATIVES, 1949

United Engineering Trustees, Inc.
James L. Head, '50 E. C. Meagher, '52
Gail F. Moulton, '53

The Engineering Foundation
E. R. Kaiser, '50 W. M. Peirce, '52
E. C. Meagher, ex officio as Pres., UET

Engineering Societies Library Board
James Douglas, '52 Frank T. Sisco, '50

American Standards Association
Mining Standardization Correlating Committee
Otto Herres, '49 H. H. Otto, '49
B. F. Tillson, '50

Alternates
E. W. Bullard, '49 Robert H. Morris, 50
E. R. Price, '50

National Research Council, Division of Engineering and Industrial Research
Oliver C. Ralston

John Fritz Medal Board of Award
Louis S. Cates, '50 W. E. Wrather, '52
Erle V. Daveler, '51 L. E. Young, '53

Hoover Medal Board of Award
Cadwallader Evans, Jr., '52
Paul D. Merica, '54
Scott Turner, '50, Chairman

Alfred Noble Prize Committee
J. R. Van Pelt, Jr., '50

Joseph A. Holmes Safety Association
S. H. Ash, '49

Joint Committee on National Defense
W. B. Plank

Washington Award Commission
Howard A. Herder, '51
Hjalmar W. Johnson, '50

Engineers Joint Council of Founder Societies
H. G. Moulton E. H. Robie
Scott Turner
James L. Head, Alternate

Engineers' Council for Professional Development
J. R. Cudworth, '50 C. E. Lawall, '51
Curtis L. Wilson, '52

Research Procedure Committee of The Engineering Foundation
E. R. Kaiser

Joint Committee on Engineering Societies Monographs
Reed W. Hyde, '49
E. M. Wise, ex officio as Chairman, Technical Publications Committee

Engineering Index, Inc.
Landon F. Strobel, '49

Inter-American Engineering Co-operation
George A. Easley Joseph P. McCulloch

Joint Committee on the Economic Status of the Engineer
Francis B. Foley Scott Turner
L. E. Young

Council, American Association for the Advancement of Science
C. H. Mathewson
Donald H. McLaughlin

MINING COURSES

M. I. Signer, Chairman

A. E. Adami
George T. Bator
W. R. Chedsey
J. Murray Riddell

METALLURGY COURSES

J. P. Spielman, Chairman

T. G. Chapman
W. E. Milligan
A. W. Schlechten
R. Schuhmann, Jr.

GEOLOGY COURSES

Norman S. Hinchey, Chairman

T. G. Andrews
C. H. Behre, Jr.
B. S. Butler
John J. O'Neill

MINERAL DRESSING COURSES

Joseph Newton, Chairman

S. R. B. Cooke
N. H. Manderfield
H. Gordon Poole
O. Cutler Shepard

GEOPHYSICS COURSES

Clyde H. Wilson, Chairman

C. A. Heiland
Sherwin F. Kelly
J. B. Macelwane
H. W. Straley

PETROLEUM ENGINEERING COURSES

Robert L. Whiting, Chairman

Wilber F. Cloud
F. A. Graser
Donald L. Katz
J. I. Laudermilk

INDUSTRIAL MINERALS AND CERAMICS COURSES

Paul G. Herold, Chairman

C. S. Crouse
A. F. Greaves-Walker
A. M. Short
J. L. Stuckey

LATIN-AMERICAN EDUCATION RELATIONS

Edward Steidle, Chairman

John C. Fox
E. M. Thomas
Francis A. Thomson
C. W. Wright

MINERAL ECONOMICS EDUCATION

W. M. Myers, Chairman

E. H. Kraus
R. D. Parks
Drury A. Pifer
Francis A. Thomson

EMPLOYMENT CONDITIONS FOR MINERAL ENGINEERS

Ben H. Parker, Chairman

G. J. Barker
C. J. Christensen
M. A. Hunter
R. Z. Williams

VOCATIONAL GUIDANCE

Charles H. Behre, Jr., Chairman

M. D. Cooper
C. D. Hulin
M. M. Leighton
H. E. McKinstry
C. H. Steele
W. T. Thom
John W. Vanderwilt

COLLEGE ENROLLMENT STATISTICS

W. B. Plank, Chairman

REGISTRATION OF ENGINEERS

H. E. Nold, Chairman

C. S. Crouse
E. A. Holbrook

MEMBERSHIP

Harry E. Krumlauf, Chairman

The Faculty Sponsors of Student Chapters and Affiliated Student Societies

NOMINATIONS

J. R. Cudworth, Chairman

A. C. Callen
A. F. Greaves-Walker
E. A. Holbrook
Francis A. Thomson

Mineral Economics Division

Established as a Division December 15, 1948

Elmer W. Pehrson, Chairman

Charles H. Behre, Jr., Vice-Chairman

W. H. Voskuil, Vice-Chairman

Felix E. Wormser, Vice-Chairman

Richard J. Lund, Secretary-Treasurer; Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio

EXECUTIVE COMMITTEE

Until Feb., 1950
Joseph A. Corgan
John D. Gill
George A. Lamb

Until Feb., 1951
Olaf P. Jenkins
W. M. Myers
H. J. Struth

Until Feb., 1952
Alan M. Bateman
M. M. Leighton
Arthur Notman

PAPERS AND PROGRAM

Charles H. Behre, Jr.

NOMINATING

Elmer W. Pehrson

OFFICERS AND COMMITTEES OF LOCAL SECTIONS OF THE AIME

1949

ALASKA

Established Nov. 19, 1947

Regular meetings last Monday of each month

Ted C. Mathews, Chairman
Patrick H. O'Neill, Vice-Chairman
Ralph B. Norris, Secretary-Treasurer
Box 643, Fairbanks, Alaska

District Vice-Chairmen

Leonard M. Berlin, Juneau, Alaska
Harold Strandberg, Anchorage, Alaska
Frank E. Love, Nome, Alaska

ARIZONA

Established July 10, 1915

P. D. I. Honeyman, Chairman
Albert Mendelsohn, First Vice-Chairman
Wesley P. Goss, Second Vice-Chairman
Ben G. Messer, Secretary-Treasurer
Miami Copper Co., Miami, Ariz.

Directors

L. M. Barker — W. C. Lawson
A. T. Barr — D. E. Mills
T. G. Chapman — J. B. Pullen
B. R. Coil — J. A. Richards
J. S. Coupal — Brent N. Rickard
E. R. Dickie — H. C. Weed
G. J. Duff — J. A. Wilcox
D. Gardner — R. I. Williams
W. I. Garms — C. F. Willis
H. M. Lavender — William Wraith, Jr.

Past Chairmen

R. W. Hughes — C. R. Kuzell
R. W. Thomas

Morenci Subsection

D. H. Orr, Jr., Chairman
William M. Koltun, Program Chairman

Ajo Subsection

W. H. Keener, Chairman
George Bell, Vice-Chairman
Richard Rhoades, Secretary-Treasurer

BLACK HILLS

Established Dec. 18, 1936

Fremont F. Clarke, Chairman
John P. Gries, First Vice-Chairman
James O. Harder, Second Vice-Chairman
A. L. Slaughter, Secretary-Treasurer
Box 846, Lead, S. Dak.

Executive Committee

Albro C. Ayres — Clarence N. Kravig
Renaldo Gallo — A. B. Needham

BOSTON

Established Sept. 20, 1911

Meets first Monday of each month, October to May, inclusive

George P. Swift, Chairman
Hugh E. McKinstry, Vice-Chairman
Roland D. Parks, Secretary-Treasurer; Massachusetts Institute of Technology, Cambridge, Mass.
Daniel Cushing — R. Maurice Tripp

CARLSBAD POTASH

Established Sept. 18, 1946

Meets third Thursday in the month except July and August

J. P. Smith, Chairman
G. E. Atwood, Vice-Chairman
E. W. Douglass, Vice-Chairman
J. G. Nutt, Secretary-Treasurer
Box 31, Carlsbad, N. Mex.
E. A. Schoeld, Program Committee Chairman

CENTRAL APPALACHIAN

Established Oct. 17, 1940

R. H. Allen, Chairman
L. W. Huber, Vice-Chairman
W. A. Staab, Vice-Chairman
J. T. Parker, Vice-Chairman
Charles T. Holland, Secretary-Treasurer, Box 836, Blacksburg, Va.

Executive Committee

John Galpin — C. E. Lawall
J. A. Hagy — B. H. Mott
G. R. Higinbotham — E. H. Shriver
G. R. Spindler

CHICAGO

Established Feb. 26, 1914

Holds dinner meeting first Wednesday of each month, October to May, inclusive, at the Chicago Bar Association

T. S. Washburn, Chairman
H. A. White, Secretary-Treasurer, Smeeth-Harwood Co., 2401 W. Cermak Road, Chicago 8, Ill.

Past Chairmen

J. E. Drapeau, Jr. — H. A. Herder
G. P. Halliwell — H. W. Johnson
A. S. Nichols

W. E. Brewster, National Director
Wilfred Sykes, Past National Director
W. R. Wright, Past National Director
W. E. Mahin, Program
W. D. Millar, Jr., Membership
M. E. Nickel, News Correspondent
H. M. St. John, Student Relations
J. H. Reese, Reception
R. Tietig, Personnel Service Representative
C. M. Squarcy, Junior Engineer Representative
D. L. Colwell, Inter-Society Representative
R. E. Laub, Inter-Society Representative
W. J. King, Inter-Society Alternate
F. L. Riddell, Inter-Society Alternate

Members-at-Large

G. J. Barker — P. R. Nichols
P. A. Beck — B. R. Queneau
Martin Dietl — W. P. Ruemmler
G. M. Enos — H. L. Walker
W. S. Lienhardt — Otto Zmeskal

CLEVELAND

Established April 17, 1936

John M. Kiefer, Jr., Chairman
Joseph F. Cerness, First Vice-Chairman
Charles H. Junge, Second Vice-Chairman
Charles H. Junge, Secretary; Cleveland Graphite Bronze Co., 17000 St. Clair Ave., Cleveland 10, Ohio
Reidar Eriksen, Treasurer

Executive Committee

Reidar Eriksen — Harold Y. Hunsicker
Milton Tilley

Committee Chairmen

E. J. Vargo, Membership
K. H. Donaldson, Program
V. F. Kalan, Publicity
J. R. Hamilton, Registration

COLORADO

Established May 23, 1913

M. I. Signer, Chairman
J. W. Vanderwilt, Vice-Chairman
J. Paul Harrison, Secretary-Treasurer
607 First National Bank Bldg., Denver 2, Colo.

Directors

E. D. Dickerman — E. J. Eisenach
C. E. Dobbin — (Climax Subsection)
M. H. Robineau
H. S. Worcester (San Juan Subsection)

San Juan Subsection

M. G. McGrath, Chairman
W. G. Fetzer, Secretary-Treasurer, P. O. Box 270, Grand Junction, Colo.

Climax Subsection

A. G. Gunnelson, Chairman
L. H. Glanville, Vice-Chairman
John Mullen, Treasurer
John P. Hamm, Secretary, Leadville, Colo.

COLUMBIA

Established Nov. 24, 1911

Holds meeting first Friday of each month except July and August

C. Y. Garber, Chairman
Howard P. Sherman, Vice-Chairman
Joseph A. Mecia, Vice-Chairman
L. A. Grant, Secretary-Treasurer; Day Mining Co., Box 795, Wallace, Idaho
Harold Kirkemo, Assistant Secretary, 466 Peyton Bldg., Spokane 8, Wash.

Snake River Subsection

Joseph A. Mecia, Vice-Chairman
Harry W. Marsh, Assistant Secretary; Idaho Min. Assoc., 304 Capitol Securities Bldg., Boise, Idaho

CONNECTICUT

Established Sept. 30, 1947

Lewis E. Thelin, Chairman
Lloyd E. Raymond, Vice-Chairman
David H. Thompson, Secretary-Treasurer, The American Brass Company, Waterbury 88, Conn.

Committee Chairmen

George F. Donahue, Membership
Theodore H. Carlson, Publicity

Director-at-Large

Walter R. Hibbard, Jr.

DELTA

Established Sept. 18, 1946

Meets second Tuesday in the month except during June, July, and August

E. N. Dunlap, Chairman
H. M. Krause, Jr., Vice-Chairman
Charles R. Blomberg, Vice-Chairman
Fred E. Simmons, Jr., Secretary-Treasurer; 1901 American Bank Bldg., New Orleans, La.
J. P. Ratliff, Jr., Journal Secretary

Directors

A. Claudet — H. C. Petersen
B. C. Craft — E. G. Robinson
J. C. Posgate

Chairmen of Committees

A. Claudet, Program
E. N. Van Duzee, Activities
H. M. Krause, Jr., Membership
P. J. Ratliff, Publicity
C. R. Blomberg, House
Dan Payne, Co-Chairman, Publicity

DETROIT

Established Feb. 18, 1936

Holds meetings third Monday of each month, except June through September

R. F. Mather, Chairman
F. P. Bens, Vice-Chairman
R. D. Chapman, Secretary, Engineering Div., Chrysler Corp., 12800 Oakland Ave., Detroit, Mich.
B. B. Beckwith, Treasurer

Executive Committee

E. W. Engle, Jr. — C. L. Raynor
R. N. Lynch — C. A. Siebert
W. B. McFerrin — E. W. Weinman

EAST TEXAS

Established April 18, 1940

Meets the second Tuesday of each month except July, August, and September

J. M. Shepherd, Chairman
W. W. Leonard, Vice-Chairman
R. F. Beery, Jr., Secretary-Treasurer Shell Oil Co., Inc., Box 32, Kilgore, Texas

John S. Bell — W. M. Jones
L. H. Dial — P. J. Lehnhard
R. M. Hess — R. T. Wade

EL PASO METALS

Established March 25, 1927

Meets second Wednesday each month

Edward M. Tittman, Chairman
J. E. Despins, Vice-Chairman
Guy E. Ingersoll, Secretary-Treasurer Texas College of Mines and Metallurgy, El Paso, Texas

Directors

Perry A. Alers — A. F. Horle
A. A. Collins — William W. Long
Hugh M. Craigie — R. J. Mellen
E. W. Donahue — W. S. Strain
T. J. Woodside

GULF COAST

Established Dec. 13, 1935

Meets third Tuesday of each month

Owen F. Thornton, Chairman
Ernest B. Miller, Jr., Vice-Chairman
A. B. Stevens, Vice-Chairman
George Fancher, Vice-Chairman
Everett F. Stratton, Secretary-Treasurer, P. O. Box 2175, Houston, Texas

Board of Directors

Fred M. Nelson, '50 — G. D. Robertson, '50
George L. Nye, '49 — L. V. Uhrig, '49
Ralph W. Wilson, '49

KANSAS

Established Nov. 17, 1948

V. J. Mercier, Chairman

District Vice-Chairmen

W. C. Pearson, Western Kansas
Gene E. Abernathy, Eastern Kansas
Daniel H. Sholtus, Wichita

W. F. Brown, Secretary-Treasurer Dowell Incorporated, 519 Union National Bank Bldg., Wichita 2, Kansas

Directors

P. T. Amstutz, Jr. — C. F. Weinaug
W. R. Warren — P. A. Witherspoon, Jr.

LEHIGH VALLEY

Established March 27, 1924

F. E. Van Voris, Chairman
R. T. Gallagher, Vice-Chairman
B. J. Larpenteur, Vice-Chairman
R. B. Hoy, Vice-Chairman
C. G. Tebelman, Jr., Secretary Bethlehem Steel Co., Mining Dept., Bethlehem, Pa.
Robert G. Peets, Treasurer

Managers

W. S. Cumings — M. L. Fuller
J. W. Guider

Committee Chairmen

W. S. Cumings, Program
M. L. Fuller, Nominating
H. R. Gault, Membership
J. F. Libsch, Student Prize Award
D. Lyons, Hospitality

MID-CONTINENT

Established Dec. 28, 1917

John P. Hammond, Chairman
J. Murray Walker, First Vice-Chairman
R. H. Gwinner, Second Vice-Chairman
Roy H. Smith, Secretary-Treasurer Stanolind Oil and Gas Co., Box 591, Tulsa, Okla.

Executive Board

C. B. Carruthers — Jack Tarner
Meyer H. Dubrow — A. W. Walker
J. M. Wanenmacher

Ex officiis

R. C. Earlougher — P. P. Manion, Jr.
P. E. Fitzgerald — C. V. Millikan

MINNESOTA

Established Dec. 20, 1920

Annual meeting second week in January; other meetings as called by the officers

W. L. Taylor, Chairman
Grover E. LeVeque, Vice-Chairman
Charles J. O'Connell, Secretary-Treasurer, 400 West Franklin Ave., Minneapolis 5, Minn.

Directors

R. H. B. Jones — Edward P. Scallon
Richard W. Whitney

MONTANA

Established Oct. 17, 1913

Meetings held the fourth Tuesday of the month except July and August

J. Hollis McCrea, Chairman
J. P. Spielman, Vice-Chairman
F. W. Strandberg, Secretary-Treasurer Anaconda Copper Mining Co., 421 Hennessy Bldg., Butte, Mont.

Executive Committee

Kuno Doerr, Jr. — E. C. Van Blarcom

Committee Chairmen

George T. Hanson, Program
Orrin D. Weeks, Membership
H. G. Satterthwaite, Nominating
Morgan H. Wright, Student Awards
William J. Waylett, Professional Development of Junior Members

NEVADA

Established Jan. 21, 1916

Louis D. Gordon, Chairman
John C. Kinnear, Jr., Vice-Chairman
Andrew C. Rice, Secretary-Treasurer Box D, University Station, Reno, Nev.

Executive Committee

Norman T. Annett — J. Ray Coulter
Samuel S. Arentz, Jr. — John M. Heizer

Reno Branch

Luncheon meeting the first Thursday of every month

Albin C. Johnson, Chairman
Albert Silver, Secretary-Treasurer

NEW YORK

Established May 19, 1911

Holds monthly meetings except February, June, July, August, and September

Theodore B. Counselman, Chairman
Thomas G. Moore, Past Chairman
Robert H. Ridgway, Vice-Chairman
John T. Sherman, Vice-Chairman
P. Malozemoff, Secretary; Newmont Mining Corp., 14 Wall St., New York 5, N. Y.
Fred D. Kay, Treasurer

Committeemen

James Douglas — Louis C. Raymond
Richard D. Mollison — James S. Vanick
Philip D. Wilson

NORTH PACIFIC

Established March 28, 1913

Meets third Thursday of each month except June, July, and August

Kenneth H. Anderson, Chairman
Lee W. Heinzinger, Vice-Chairman
W. C. Leonard, Secretary-Treasurer Tacoma Smelter, American Smelting & Refining Co., 3709 No. Madison, Tacoma, Wash.
Drury A. Pifer, Corresponding Secretary

Counselors

Paul T. Benson — E. R. McMillan
H. F. Yancey

NORTH TEXAS

Established May 16, 1945

Don L. Harlan, Chairman
J. A. Slicker, Vice-Chairman for Fort Worth
J. A. Crichton, Vice-Chairman for Dallas
I. E. Curtis, Vice-Chairman for Wichita Falls
S. V. McCollum, Secretary-Treasurer Continental Oil Co., 1710 Fair Bldg., Fort Worth 2, Texas

Directors

D. H. Clewell — Tom E. Morton
W. J. Jackson — W. D. Sorrells
E. E. Merkt, Jr. — L. P. Wharton

OHIO VALLEY

Established Nov. 19, 1920

William A. Mueller, Chairman
Donald W. Scott, Vice-Chairman
John H. Melvin, Secretary-Treasurer State Geologist, Ohio Geological Survey, Ohio State University, Columbus 10, Ohio
Frank G. Smith, Assistant Secretary-Treasurer

Chairmen

R. J. Lund, Program Committee
Homer Faust, Membership Committee
Cloyd A. Snavely, Representative, Junior Members
John A. Schumann, Representative, Student Associates
Clyde Williams, National Director

Area Representatives

C. E. Bales, Portsmouth
W. B. Berwald, Findlay
Robert S. Bower, Cincinnati
C. R. FonDersmith, Middletown
George R. Long, Dayton
James D. Reilly, St. Clairsville
Max A. Tuttle, Indianapolis
R. M. Woodward, Newark

OKLAHOMA CITY

Established Feb. 18, 1947

Lincoln F. Elkins, Chairman
Nico Van Wingen, Vice-Chairman
Henry Waszkowski, Vice-Chairman
Martin O. Hegglund, Secretary-Treasurer, Stanolind Oil and Gas Co., 2003 First National Bldg., Oklahoma City, Okla.

Directors

R. J. Beams — C. E. Clason — H. R. Sells

OREGON

Established April 22, 1921

Meets third Friday of each month except during summer months

H. M. Dole, Chairman
J. H. Leary, Vice-Chairman
S. H. Lorain, Past Chairman
A. O. Bartell, Secretary-Treasurer, 321 Platt Bldg., Portland 5, Oregon

Executive Committee

D. H. Beetem — F. W. Libbey

PENNSYLVANIA-ANTHRACITE

Established Feb. 17, 1914

Spring meeting, April; Summer meeting, July; Fall meeting, October
Meetings held alternately at Pottsville, Hazleton, Wilkes-Barre, and Scranton

William B. Geise, Chairman
George A. Roos, Vice-Chairman
Floyd S. Sanders, Secretary-Treasurer, Goodman Mfg. Co., P. O. Box 151, 35 New Bennett St., Wilkes-Barre, Pa.

Executive Committee

H. J. Connolly — F. E. Kudlich
W. E. Conroy — H. D. Kynor
C. Evans, Jr. — Earl W. Lamb
C. A. Gibbons — J. C. MacCartney
Edward Griffith — H. W. Montz
D. C. Helms — W. C. Muehlhof
Wilmot Jones — Walter B. Petzold
Joseph E. Ward

PERMIAN BASIN

Established Nov. 14, 1945

Thomas C. Frick, Chairman

W. N. Little, Vice-Chairman

J. M. Moore, Secretary-Treasurer; Dist. Engr., Dowell, Incorporated, Box 1858, Midland, Texas

Directors

Burton Atkinson — W. N. Little
William L. Crothers — Lamar Lunt
Thomas C. Frick — J. M. Moore

Committee Chairmen

W. N. Little, Program
Joe Chastain, Membership

PHILADELPHIA

Re-established March 15, 1944

F. B. Foley, Chairman

A. W. Grosvenor, Vice-Chairman

A. L. Jamieson, Vice-Chairman

F. J. Dunkerley, Secretary-Treasurer 247 Engineering Bldg., University of Pennsylvania, Philadelphia 4, Pa.

Executive Committee

C. B. Allen — D. I. Finch
R. M. Brick — Leopold Pessel

PITTSBURGH

Established 1920

H. P. Greenwald, Chairman

G. J. Donaldson, Vice-Chairman

George H. Enzian, Secretary; Jones & Laughlin Steel Corp., 40 Longworth St., Pittsburgh 7, Pa.

R. F. Miller, Treasurer

W. L. Affelder — M. F. Hawkes
N. G. Alford — K. C. Heald
M. D. Cooper — E. H. Hollingsworth
D. H. Davis — S. Krickovic
G. H. Deike — E. Leatham
G. R. Fitterer — J. T. Ryan, Jr.
M. G. Gulley — R. E. Sherrill
J. C. Sullivan

Ex officiis

H. N. Eavenson — S. A. Taylor

Open-Hearth Committee

A. W. Thornton, Chairman

J. F. Pollack, Secretary

H. E. Johnson, Executive Secretary

C. Longenecker, Treasurer

ST. LOUIS

Established May 23, 1913

Herbert A. Franke, Chairman

H. A. Neustaedter, Vice-Chairman

N. A. Stockett, Past Chairman

Fred J. Meek, Secretary-Treasurer American Zinc Co. of Illinois, Box 495, East St. Louis, Ill.

K. A. Phillips, Program Chairman

Executive Committee

W. R. Chedsey — John D. Kerr, Jr.
J. C. George — Gill Montgomery
Curtis L. Wilson

SAN FRANCISCO

Established June 26, 1913

Meets second Wednesday of each month except June, July, and August: and Monday noons for luncheon at Engineers' Club

Edward H. Wisser, Chairman

Philip R. Bradley, Jr., Vice-Chairman

George H. Playter, Secretary-Treasurer Room 820, 405 Montgomery St., San Francisco 4, Calif.

Executive Committee

P. R. Bradley, Jr. — W. W. Mein, Jr.
W. C. Collyer — Walter L. Penick
Carlton D. Hulin — George H. Playter
Edward H. Wisser

Committee Chairmen

Philip R. Bradley, Jr., Program
J. Ward Downey, Membership
Frank S. Hudson, Student Contact
Olaf P. Jenkins, Student Prize
Lawrence B. Wright, Licensing
Granville S. Borden, Entertainment and Hospitality
Worthen Bradley, Advisory
Ira B. Joralemon, Nominating
William C. Collyer, Finance
Edward W. Bullard, Advisory Committee of Engineering Societies Personnel Service
Philip R. Bradley, Jr., Legislative
Edward H. Wisser, Engineering Council

SOUTHEAST

Established Feb. 18, 1936

J. C. Gray, Chairman

William C. Chase, First Vice-Chairman

W. C. McKenzie, Second Vice-Chairman

Reynold Q. Shotts, Secretary-Treasurer; University of Alabama, Box 1526, University, Ala.

Committee Chairmen

E. H. Rose, Program
Howard Cobb, Membership and Attendance
G. T. Bator, Student Relations and the Development of Junior Engineers
Ronald F. Crawford, Publicity
Neil O. Johnson, Entertainment
Francis H. Crockard, Student Counselor

SOUTHERN CALIFORNIA

Established May 23, 1913

Harold J. Clark, Chairman

H. B. Menardi, Vice-Chairman for Mining

Paul Andrews, Vice-Chairman for Petroleum

L. W. Chasteen, Secretary, 617 W. 7th St., Los Angeles 14, Calif.

W. H. Geis, Treasurer

Thomas Clements — John R. McMillan
Richard H. Jahns — George W. Nilsson
C. T. McClure — Dean H. Sheldon
Stuart H. Ingram, Past Chairman

Committee Chairmen

Nicholas A. D'Arcy, Jr., Membership
Paul Andrews, Programs and Legislative
Richard L. Parsons, Student Awards
Stuart H. Ingram, Nominating
Leo Schapiro, Institute of Metals and Iron and Steel Divisions
Ian Campbell, Industrial Minerals Division
George D. Dub, Mining and Milling

Junior Division

C. T. McClure, Chairman
I. I. Dagan, Secretary
R. L. Parsons, Treasurer

Committee Chairmen

N. M. Norman, Program
I. A. Marshall, Membership

SOUTHWEST TEXAS

Established Sept. 18, 1946

Meets third Wednesday of each month except July and August

Raoul J. Bethancourt, Chairman

Charles Snelson, Vice-Chairman

R. C. Granberry, Secretary-Treasurer Humble Oil and Refining Co., Corpus Christi, Texas

Directors

Barrett Booth — H. N. Lyle
Emil Bowers — Harold Moseley
Lee J. Thronson

SOUTHWESTERN NEW MEXICO

Established Sept. 30, 1947

Holds meeting second Wednesday in January, April, July, and October

Joseph H. Taylor, Chairman

F. C. Green, First Vice-Chairman

Leo H. Duriez, Second Vice-Chairman

W. R. Storms, Secretary-Treasurer U. S. Bureau of Mines, Silver City, N. Mex.

Committee Chairmen

John G. Reilly, Membership
T. A. Snedden, Program

TRI-STATE

Established May 27, 1926

Harold A. Krueger, Chairman

Ernest Blessing, Vice-Chairman

J. C. Stipe, Secretary-Treasurer, 715 E. 15th St., Baxter Springs, Kans.

Directors

O. W. Bilharz — Elmer Isern
Ernest Blessing — H. A. Krueger
F. J. Cuddeback — J. P. Lyden
G. M. Fowler — C. Y. Thomas

Committee Chairmen

S. S. Clarke, Program
Ernest Blessing, Membership

UPPER PENINSULA

Established Oct. 25, 1918

H. S. Peterson, Chairman

Roy W. Drier, Secretary-Treasurer Michigan College of Mining and Technology, Houghton, Mich.

Executive Committee

C. W. Allen — W. E. Seppansen
E. C. Carlson — D. L. Watts

Advisory Committee

Roy W. Drier — Grover Holt

UTAH SECTION

Established April 24, 1914

Meets third Thursday of each month, September to May inclusive

J. C. Landenberger, Jr., Chairman

Byron E. Grant, Vice-Chairman

R. C. Cole, Secretary-Treasurer Pacific National Life Bldg., Salt Lake City 1, Utah

Executive Committee

C. J. Christensen — M. B. Kildale
J. M. Ehrhorn — W. G. Rouillard

Committee Chairmen

J. K. Richardson, Membership
Burt B. Brewster, Publicity
Robert S. Lewis, Student Affairs
K. Fritz Eilers, Entertainment

WASHINGTON, D. C.

Established June 21, 1918

Meets generally third Tuesday of the month except June, July, and August

Thomas H. Miller, Chairman

E. W. Ellis, Vice-Chairman for D. C.

C. J. Williamson, Vice-Chairman for Md.

E. J. Lintner, Vice-Chairman for Va.

Forrest T. Moyer, Secretary-Treasurer U. S. Bureau of Mines, Room 1364, Interior Bldg., Washington 25, D. C.

Executive Committee

John J. Croston — H. I. Smith

Member of President's Advisory Council

S. Power Warren

WYOMING

Established May 16, 1930

Regular meetings held quarterly; special meetings when speakers available.

I. M. Charles, Chairman

M. M. Fidlar, Vice-Chairman

J. H. Quay, Secretary-Treasurer; Union Pacific Coal Co., Rock Springs, Wyo.

Executive Committee

I. N. Bayless — C. C. Boley
H. C. Livingston

FOREIGN

PHILIPPINE

Established Jan. 20, 1939

Homer A. Mann, Chairman

M. M. Aycardo, Jr., Secretary-Treasurer; International Engineering Corp., Soriano Bldg., 3rd Fl., Manila, P. I.

Finance Committee

Steve Arick — G. J. Scheuermann

Program Committee

N. A. Fittinghoff — G. D. Strachan

RIO DE JANEIRO (BRAZIL)

Established April 17, 1936

E. de Macedo Soares S., Chairman

A. I. de Oliveira, Vice-Chairman

A. H. Garner, Vice-Chairman

Sylvio Froes Abreu, Secretary; Instituto Nacional de Tecnologia, Rio de Janeiro, Brazil

Officers
Affiliated Student Societies of the AIME
1949

UNIVERSITY OF ALABAMA
University, Ala.
*Mining and Metallurgical Society**
G. L. Roberts, President
T. G. Patterson, Vice-President
B. B. Copeland, Treasurer
K. F. Stark, Secretary
G. T. Bator, Faculty Sponsor
F. H. Crockard, Counselor

UNIVERSITY OF ALASKA
College, Alaska
*Mining Society**
Daniel A. Jones, President
Robert L. Marovelli, Vice-President
Edward T. Barnes, Secretary
Frederick F. Kohls, Treasurer
Earl H. Beinstline, Faculty Sponsor
Alan Probert, Counselor

UNIVERSITY OF ARIZONA
Tucson, Ariz.
*Miners' Society**
Robert I. Williams, President
Edwin B. King, Vice-President
Robert O. Wenzel, Treasurer
Arthur E. Himebaugh, Secretary
J. B. Cunningham, Faculty Sponsor
Edward Holderness, Counselor

BIRMINGHAM-SOUTHERN COLLEGE
Birmingham, Ala.
*The Student Geological Society of Birmingham-Southern College**
Edward E. Walters, President
Audley W. Downs, Vice-President
Howard H. Odiorne, Secretary
Abner B. Chapman, Treasurer
J. Allen Tower, Faculty Sponsor

UNIVERSITY OF CALIFORNIA
Berkeley, Calif.
Mining Association
Albert L. McGuinness, President
Val L. Freeman, Vice-President
Ronald N. Skow, Secretary
Crawford E. Jacobsen, Treasurer
Bernard York, Faculty Sponsor
B. A. Gould, Counselor

UNIVERSITY OF CALIFORNIA AT LOS ANGELES
Los Angeles, Calif.
*Student Chapter, AIME**
(Inactive)

CARNEGIE INSTITUTE OF TECHNOLOGY
Pittsburgh, Pa.
The Metals Society
Lee Horigan, President
John Brown, Jr., Vice-President and Treasurer
Michael Stavish, Secretary
Malcolm F. Hawkes, Faculty Sponsor
Max Gensamer, Counselor

CASE INSTITUTE OF TECHNOLOGY
Cleveland, Ohio
*Pick and Shovel Club**
D. E. Tanger, President
F. F. Awig, Vice-President
R. C. Hall, Secretary
R. T. Bubsey, Treasurer
Gerald M. Cover, Faculty Sponsor

UNIVERSIDAD CENTRAL
Caracas, Venezuela
*Asociacion Venezolana de Estudiantes de Geologia**
(Inactive)

THE CITY COLLEGE OF NEW YORK
New York, N. Y.
*C. C. N. Y. Student Chapter, AIME**
Herbert Feely, President
Jack Tarr, Vice-President
Julius Jettelson, Secretary
Seymour Feerst, Treasurer
Daniel T. O'Connell, Faculty Sponsor
Benjamin F. Tillson, Counselor

COLORADO SCHOOL OF MINES
Golden, Colo.
*Student Chapter of AIME**
Herman Knight, President
Bill Baker, Secretary-Treasurer
Harvey W. Smith, Public Relations Chairman
T. A. Hoy, Director
Jack Dempsey, Director
George W. Heim, Faculty Sponsor

COLUMBIA UNIVERSITY
New York, N. Y.
*Thomas Thornton Read Society of the Columbia School of Mines**
Robert C. Musa, President
George R. Prescott, Vice-President
Joseph F. Brown, Treasurer
Roger D. Lopez, Secretary
Seymour Goodman, Corresponding Secretary
John C. Fox, Faculty Sponsor
Felix E. Wormser, Counselor

CORNELL UNIVERSITY
Ithaca, N. Y.
Cornell Metallurgical Society
Nicholas Sheptak, President
Albert H. Moon, Vice-President
Paul L. Widener, Secretary
Robert L. Folkman, Treasurer
J. L. Gregg, Faculty Sponsor
Stanley M. Norwood, Counselor

DRURY COLLEGE
Springfield, Mo.
*Drury Rockhounds**
(Inactive)

ESCUELA NACIONAL DE INGENIEROS
Mexico, D. F.
*Sociedad Andres M. Del Rio**
(Inactive)

UNIVERSITY OF IDAHO
Moscow, Idaho
Associated Miners
Phillip A. Beeson, President
Donald Gordon Dahle, Vice-President
Arthur Guy Randall, Secretary-Treasurer
Joseph Newton, Faculty Sponsor

UNIVERSITY OF ILLINOIS
Urbana, Ill.
Mineral Industries Society
Edward John Sperr, President
Norbert B. Blaski, Vice-President
Beverly Solliday, Secretary
Verle B. Utzinger, Treasurer
William R. Chedsey, Faculty Sponsor
Paul R. Nichols, Counselor

ILLINOIS INSTITUTE OF TECHNOLOGY
Chicago, Ill.
*Student Chapter, AIME**
Edward Murway, President
Robert Domagala, Secretary
O. Zmeskal, Faculty Sponsor
L. F. Mondolfo, Faculty Sponsor
T. S. Washburn, Counselor

IOWA STATE COLLEGE
Ames, Iowa
*Iowa State Mining Society**
Lloyd Daniel Brownson, President
Donald D. Turner, Vice-President
Edgar A. Perry, Secretary-Treasurer
Charles O. Frush, Faculty Sponsor

UNIVERSITY OF KANSAS
Lawrence, Kansas
*University of Kansas Student Chapter AIME**
Wayne C. Capron, President
Kenneth O. Austin, Vice-President
Edward B. Harry, Secretary
James C. Henderson, Treasurer
Eugene A. Stephenson, Faculty Sponsor

UNIVERSITY OF KENTUCKY
Lexington, Ky.
*Norwood Mining and Metallurgical Society**
Ralph W. Preston, Jr., President
Harry L. Kirkpatrick, Vice-President
Everett A. Wick, Secretary
Harry L. Washburn, Treasurer
C. S. Crouse, Faculty Sponsor
H. Comer Wolf, Counselor

*Student Chapter, AIME. Membership composed of Student Associates of the AIME.

LAFAYETTE COLLEGE
Easton, Pa.
John Markle Society
E. Nelson Strang, President
Channing B. Mould, Vice-President
John M. Siergiej, Secretary-Treasurer
Bernard J. Fischer, Faculty Sponsor

LEHIGH UNIVERSITY
Bethlehem, Pa.
Howard Eckfeldt Mining and Geological Society
David Ford, President
Douglas Sammack, Vice-President
Malcolm Wane, Secretary
John Joyce, Treasurer
H. R. Gault, Faculty Sponsor

LOUISIANA STATE UNIVERSITY
University, La.
*Student Chapter, AIME**
James W. Law, President
Jack Simpson, Vice-President
Jerry Shea, Secretary-Treasurer
Mahlon F. Manville, Corresponding Secretary
B. C. Craft, Faculty Sponsor
H. F. Winham, Counselor

MACKAY SCHOOL OF MINES UNIVERSITY OF NEVADA
Reno, Nev.
Crucible Club
Alberto H. Barrios, President
Robert C. Horton, Vice-President
William D. Williams, Secretary
Gerald E. Knowles, Treasurer
William I. Smythe, Faculty Sponsor
Louis D. Gordon, Counselor

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Mass.
*Metallurgical Society**
John D. Yerger, Jr., President
Robert N. Randall, Vice-President
Kenneth W. McGrath, Secretary
Jan M. Hoegfeldt, Treasurer
H. Rush Spedden, Faculty Sponsor
Daniel Cushing, Counselor

UNIVERSITY OF MICHIGAN
Ann Arbor, Mich.
University of Michigan Affiliated Student Society, AIME
Charles W. Phillips, President
Frank L. Yaggee, Vice-President
G. H. Hilbers, Jr., Secretary-Treasurer
Kenneth F. Packer, Recording Secretary
Clarence A. Siebert, Faculty Sponsor

MICHIGAN COLLEGE OF MINING AND TECHNOLOGY
Houghton, Mich.
*Mining Club**
Rodger H. Chapman, President
Harry A. Toelle, Jr., Vice-President
Don Avery, Treasurer
James J. Walker, Secretary
Charles M. Harry, Faculty Sponsor
C. Harry Benedict, Counselor

UNIVERSITY OF MINNESOTA
Minneapolis, Minn.
*University of Minnesota Student Chapter, AIME**
Lyle Campbell, President
Albert Alexander, Vice-President
Morris Sandvig, Secretary-Treasurer
John Sumner, Program Chairman
R. L. Dowdell, Faculty Sponsor
Robert D. Longyear, Counselor

MISSOURI SCHOOL OF MINES AND METALLURGY
Rolla, Mo.
*Missouri School of Mines and Metallurgy Student Chapter, AIME**
James B. Chaney, President
Edward Aubuchon, Vice-President
D. Castleberry, Treasurer
Albert Jones, Secretary
D. R. Schooler, Faculty Sponsor
Leon W. Dupuy, Counselor

MONTANA SCHOOL OF MINES
Butte, Mont.
*Anderson Carlisle Technical Society**
Leonard Powell, President
Dare Boulter, Vice-President
Carl Howald, Secretary-Treasurer
Curtis L. Graversen, Faculty Sponsor

UNIVERSITY OF NEW HAMPSHIRE
Durham, N. H.
*University of New Hampshire Student Chapter, AIME**
Joseph T. Callahan, President
Carl A. Lein, Vice-President
L. W. Wakefield, Secretary-Treasurer
Marston Chase, Corresponding Secretary
T. R. Meyers, Faculty Sponsor
Daniel Cushing, Counselor

UNIVERSITY OF NEW MEXICO
Albuquerque, N. Mex.
University of New Mexico Affiliated Student Society
Philip T. Hayes, President
Ernest Rich, Vice-President
Peggy Cannedy, Secretary-Treasurer
Vincent C. Kelley, Faculty Sponsor
C. T. Griswold, Counselor

NEW MEXICO SCHOOL OF MINES
Socorro, N. Mex.
*Cooney Mining Club**
Ray Ballmer, President
Thomas O. Perrott, Vice-President
Harold B. Russell, Secretary-Treasurer
William W. Long, Faculty Sponsor

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING
Raleigh, N. C.
*Rockhound Club**
C. H. Robinson, President
M. B. Corriher, Jr., Vice-President
W. G. Wells, Jr., Secretary
F. L. Dillard, Treasurer
Warren G. Steel, Faculty Sponsor
J. Frank West, Counselor

UNIVERSITY OF NORTH DAKOTA
Grand Forks, N. Dak.
*Mining Club**
Wayne D. Wavrin, President
Donald K. Nelson, Vice-President
John H. Fyten, Secretary-Treasurer
A. W. Koth, Faculty Sponsor
L. C. Harrington, Counselor

OHIO STATE UNIVERSITY
Columbus, Ohio
Mineral Industries Society
Benjamin Roth, President
Thomas L. Chase, Vice-President
John Schumann, Secretary-Treasurer
W. A. Mueller, Faculty Sponsor
William Heimberger, Counselor

UNIVERSITY OF OKLAHOMA
Norman, Okla.
*Petroleum Engineers Club**
Gene C. Bankston, President
Preston G. Rennie, Vice-President
Charles Robert Olson, Secretary-Treasurer
Lewis L. Barnes, Publicity Director
Kenneth R. Boles, St. Pat's Counselor
Jim Gough, Entertainment Director
W. F. Cloud, Faculty Sponsor

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE
Stillwater, Oklahoma
Petroleum Engineering Club
Lewis Smith, President
Bob Brakey, Vice-President
James E. Brazell, Secretary
J. W. Jackson, Treasurer
Ray L. Six, Faculty Sponsor

OREGON STATE COLLEGE
Corvallis, Oreg.
*Oregon State College Student Chapter of the AIME**
Ronald F. Robberson, President
James G. Osborne, Jr., Secretary-Treasurer
Ira S. Allison, Faculty Sponsor
Fay W. Libbey, Counselor

UNIVERSITY OF PENNSYLVANIA
Philadelphia, Pa.
Metallurgical Engineering Society
David Goldstein, President
Victor Damiano, Secretary
R. M. Brick, Faculty Sponsor
A. O. Schaefer, Counselor

THE PENNSYLVANIA STATE COLLEGE
State College, Pa.
*Penn. State M. I. Society**
Samuel W. Llewellyn, President
Thomas B. Budinger, Vice-President
James G. Tilton, Secretary-Treasurer
A. W. Asman, Faculty Sponsor

*Petroleum Engineering Society**
N. Dean Altimus, President
Robert C. Merkle, Vice-President
F. C. Bence, Secretary-Treasurer
P. W. Huber, Corresponding Secretary

POLYTECHNIC INSTITUTE OF BROOKLYN
Brooklyn, N. Y.
Student Chapter, AIME
Robert E. King, President
Robert P. Wittmann, Vice-President
Fred E. Weisser, Secretary
William A. Corigliano, Treasurer
Otto H. Henry, Faculty Sponsor
Stanislaus Skowronski, Counselor

COLLEGE OF PUGET SOUND
Tacoma, Wash.
*The Geological Society**
Richard C. Bligh, President
Glan Holmberg, Secretary
F. A. McMillin, Faculty Sponsor
Eugene A. White, Counselor

PURDUE UNIVERSITY
Lafayette, Ind.
Purdue University Student Society, AIME
R. E. Schotz, President
T. G. Johnston, Jr., Vice-President
W. H. Roberts, Secretary
C. R. McKinsey, Treasurer
George M. Enos, Faculty Sponsor
W. John King, Counselor

RUTGERS UNIVERSITY
New Brunswick, N. J.
*The Rutgers Geology Club**
Gerald Wasserburg, President
Clarence V. Pierce, Vice-President
Worth B. Cunningham, Jr., Secretary-Treasurer
Helgi Johnson, Faculty Sponsor
J. D. Grothe, Counselor

ST. LOUIS UNIVERSITY INSTITUTE OF TECHNOLOGY
St. Louis, Mo.
Student Chapter, AIME
S. C. Judge, III, President
D. D. Barman, Vice-President
Thomas Parker, Secretary-Treasurer
W. J. Gabriel, Corresponding Secretary
A. J. Frank, Faculty Sponsor

UNIVERSITY OF SOUTHERN CALIFORNIA
Los Angeles, Calif.
*Student Chapter, AIME**
Archibald M. Laurie, President
Richard S. Davis, Vice-President
Robert J. Fernandes, Secretary
Robert R. Shaffer, Treasurer
Richard Davis, Membership Committee
Richard Brazier, Program Committee
John P. McGriff, Parliamentarian

SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY
Rapid City, S. Dak.
*Drill and Crucible Club**
Ralph C. Flow, President
Henry L. Hurley, Vice-President
Russell F. Gamberg, Secretary
Edward F. Jacobson, Treasurer
J. P. Gries, Faculty Sponsor

STANFORD UNIVERSITY
Stanford University, Calif.
The Geological and Mining Society of Stanford University
Harry Ptasynski, President
R. Garvin Berry, Jr., Vice-President
Edward A. Gribi, Jr., Secretary-Treasurer
Charles F. Park, Jr., Faculty Sponsor
F. G. Tickell, Counselor
S. W. Muller, Counselor

TANGSHAN ENGINEERING COLLEGE
Nan Yang University, Shanghai, China
*The AIME Student Chapter at Tangshan Engineering College**
Yao Check-Yin, President
Chou Tsu-Ting, Secretary
Chen Young-Kai, Treasurer
Jan Shi Sen, Faculty Sponsor

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
College Station, Texas
Petroleum Engineering Club
Richard K. Epps, President
Paul Ravesies, Vice-President
Charles R. Mitchell, Treasurer
Harry L. Dedman, Secretary
Robert L. Whiting, Faculty Sponsor

TEXAS COLLEGE OF MINES AND METALLURGY
(Branch of the University of Texas)
El Paso, Texas
Mining Club
Louis W. Cope, President
Antonio Obregon, Vice-President
Richard E. Lindberg, Secretary
John F. Graham, Faculty Sponsor
E. M. Tittman, Counselor

TEXAS TECHNOLOGICAL COLLEGE
Lubbock, Texas
Society of Petroleum Engineers and Geologists
James McMurray, President
Clyde H. Pickens, Vice-President
Marguerite Weeks, Secretary
Loraine Sparks, Treasurer
Fred Thompson, Corresponding Secretary

UNIVERSITY OF TEXAS
Austin, Texas
University of Texas Affiliated Society of AIME
R. R. Wallace, President
Aaron Cawley, Vice-President
John Kirby, Secretary
Charles Hancock, Treasurer
J. M. Lebeaux, Faculty Sponsor

UNIVERSITY OF TORONTO
Toronto, Ont.
University of Toronto Mining and Metallurgical Club
Toronto Campus
E. C. Hodgson, President
W. Curlock, Vice-President
R. W. Boyle, Secretary-Treasurer
Ajax Division
S. W. Wright, President

UNIVERSITY OF TULSA
Tulsa, Okla.
*University of Tulsa Student Chapter, AIME**

UNIVERSITY OF UTAH
Salt Lake City, Utah
*Mining Society of the University of Utah**
Jason E. Everts, President
Walter O'Toole, Vice-President
Alan King, Secretary-Treasurer
Robert S. Lewis, Faculty Sponsor
James K. Richardson, Counselor

VIRGINIA POLYTECHNIC INSTITUTE
Blacksburg, Va.
*Burkhart Student Chapter, AIME**
Walter N. Bond, President
Frank L. Gaddy, Vice-President
Albert E. Singleton, Jr., Secretary-Treasurer
L. I. Cothern, Faculty Sponsor
J. A. Hagy, Counselor

WASHINGTON UNIVERSITY
St. Louis, Mo.
*Walter E. McCourt Memorial Chapter**
Albert O. Wilkat, President
Nelson E. Lurton, Jr., Vice-President
Y. William Isachsen, Secretary-Treasurer
H. L. Sharon, Faculty Sponsor
Herbert A. Franke, Counselor

STATE COLLEGE OF WASHINGTON
Pullman, Wash.
Associated Muckers
George Becraft, President
Charles Hummel, Vice-President
Rodney Carden, Secretary
Betty Enbysk, Treasurer
Donald L. Masson, Faculty Sponsor

UNIVERSITY OF WASHINGTON
Seattle, Wash.
The Mines Society
C. H. Fidler, President
William Norem, Vice-President
R. J. J. Lampson, Secretary-Treasurer
Joseph Daniels, Faculty Sponsor

WEST VIRGINIA UNIVERSITY
Morgantown, W. Va.
The Mining Society
Robert H. Edele, President
Paul E. Owens, Vice-President
Walter A. Detamore, Secretary-Treasurer
R. W. Laird, Faculty Sponsor
G. R. Spindler, Counselor

UNIVERSITY OF WICHITA
Wichita, Kansas
Geology Club
Robert Watchous, President
Elbie McNeil, Vice-President
Claude Sheats, Secretary
Doug McGinness, Treasurer
J. R. Berg, Faculty Sponsor
A. Koester, Counselor

UNIVERSITY OF WISCONSIN
Madison 6, Wis.
Mining Club
Robert K. Allen, President
John Althouse, Vice-President
Charles Pitt, Secretary-Treasurer
Robert Hueschen, Chief Mucker
Philip C. Rosenthal, Faculty Sponsor
C. V. Nass, Counselor

YALE UNIVERSITY
New Haven, Conn.
*Yale Metallurgical Society**
D. A. Nankivell, President
Harold Margolin, Vice-President
V. T. Potter, Secretary
C. H. Stokesbury, Jr., Treasurer
W. R. Hibbard, Jr., Faculty Sponsor
J. L. Christie, Counselor

Princeton University, University of Pittsburgh and University of the Philippines student societies are inactive.

THE WOMAN'S AUXILIARY, 1949

PRESIDENT
Mrs. Thorne E. Lloyd
14 Green Hill Road Morristown, N. J.

FIRST VICE-PRESIDENT
Mrs. H. Y. Eagle
2 Fifth Ave. New York, N. Y.

SECOND VICE-PRESIDENT
Mrs. David Eugene Park
30 Sutton Place New York, N. Y.

THIRD VICE PRESIDENT
Mrs. Loyal George Tinkler
233 Gardner Road Ridgewood, N. J.

FOURTH VICE-PRESIDENT
Mrs. M. F. Coolbaugh
1700 Maple St. Golden, Colo.

FIFTH VICE-PRESIDENT
Mrs. Rollin A. Pallanch
1654 Millbrook Rd. Salt Lake City, Utah

RECORDING SECRETARY
Mrs. Thomas T. Read
9 Windmill Lane Scarsdale, N. Y

ASSISTANT RECORDING SECRETARY
Mrs. Robert Y. Woodul
320 East 72d St. New York, N. Y.

CORRESPONDING SECRETARY
Mrs. Theodore Nagel
76 Remsen St. Brooklyn, N. Y.

TREASURER
Mrs. George D. Barron
Box 217 Rye, N. Y.

ASSISTANT TREASURER
Mrs. Robert Hursh
River Road, Silvermine Norwalk, Conn.

Baroid

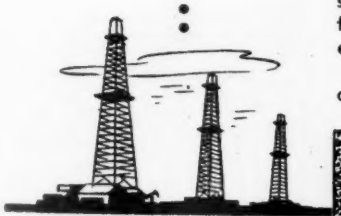
IMPERMEX MAKES GOOD MUD FOR BAD CONDITIONS

IMPERMEX, Baroid's organic colloidal material, provides superior drilling muds in spite of the presence of such contaminants as salt, anhydrite, gypsum, and cement. Operators have found it unexcelled for drilling through zones which might cause the discard of ordinary drilling fluids.

IMPERMEX has long served the industry as a means of providing muds with marvelous filtration properties particularly useful for completion work. It finds more and more application in zones where its extremely low water loss, thin filter cake, and resistance to contamination enable the operator to drill ahead with a minimum of trouble, loss of time, and damage to the formation.

IMPERMEX makes any clay mud a better mud, whether mixed with fresh water or brine. In some areas the employment of IMPERMEX muds has become standard practice. Many deep high-pressure wells have been drilled successfully largely because the use of IMPERMEX has produced workable muds of extremely high density, thin filter cake, and low water loss.

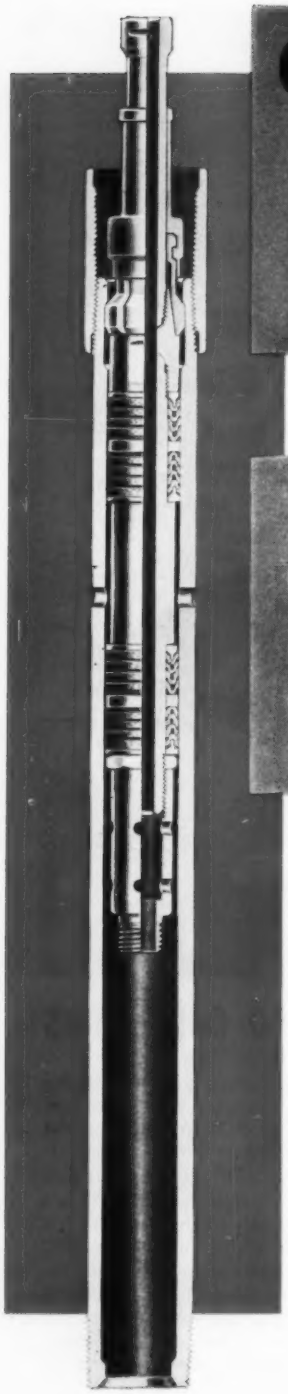
Let the Baroid service engineer in your district show you how IMPERMEX can save you time and trouble in your wells.



BAROID SALES DIVISION

NATIONAL LEAD COMPANY

LOS ANGELES 12 • TULSA 3 • HOUSTON 2



over 18 different single and two-zone operations can be performed with

OTIS REMOVABLE SIDE-DOOR CHOKES *and supplementary two-zone equipment*

The broad range of types and adaptability of Otis single and two-zone completion and production equipment does not limit its use either geologically or mechanically. Here are some of the standard applications:

Bringing in both zones simultaneously of a dual well through the tubing, then producing each zone separately; bringing in a single-zone well through the tubing after surface connections have been permanently installed; testing tubing for leaks before a single or two-zone well is brought in; killing a single or two-zone well immediately without waiting for wire line equipment; conditioning mud above the packer of a single-zone well; acidizing or taking bottom hole pressures of a single-zone well; acidizing separately or taking separate bottom hole pressures of each zone of a two-zone well; admitting gas injected into the annulus, or gas from the upper portion of the formation above a packer, at a controlled rate to assist flow through the tubing; reducing gas-oil ratios to provide more efficient flow from both zones of a two-zone well, etc.

Otis engineers and trained personnel are available to discuss all standard and special applications of Otis single and two-zone completion and production equipment. Write Otis Pressure Control, Inc., Box 7206, Dallas, Texas. Ask for our 16-page, 4-color, illustrated "Side-Door Choke" catalog.

PRESSURE CONTROL – OTIS – SERVICE – EQUIPMENT

OTIS PRESSURE CONTROL, INC.

SIDE-DOOR CHOKES

(T-21)

FIELD OFFICES **TEXAS:** HOUSTON, CORPUS CHRISTI, ODESSA and LONGVIEW. **OKLAHOMA:** OKLAHOMA CITY. **LOUISIANA:** NEW IBERIA

OTIS ENGINEERING CORPORATION – MANUFACTURE AND DEVELOPMENT

DISTRIBUTORS. **OTIS PRESSURE CONTROL, INC.**, DALLAS, TEX. **OTIS EASTERN SERVICE, INC.**, BOLIVAR, N. Y. **WESTERN PRESSURE CONTROL**, LOS ANGELES, CALIF.

EXPORT SALES AND SERVICES. **OTIS PRESSURE CONTROL EXPORT, INC.**, POST OFFICE BOX 7206, DALLAS, TEXAS, U. S. A., CARACAS, SOUTH AMERICA

DISCUSSION OF THIS AND ALL FOLLOWING TECHNICAL PAPERS IS INVITED

Discussion in writing (3 copies) may be sent to the Editor, *Journal of Petroleum Technology*, 601 Continental Building, Dallas 1, Texas, and will be considered for publication in the Transactions volume *Petroleum Development and Technology*. Discussion will close December 15, 1949. Any discussion offered thereafter should be in the form of a new paper.

BEHAVIOR OF BINARY, TERNARY, AND MULTICOMPONENT SYSTEMS AT STATES SIMILAR TO THOSE ENCOUNTERED IN CONDENSATE FIELDS

B. H. SAGE, MEMBER AIME, AND **W. N. LACEY**

CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIFORNIA

ABSTRACT

The growing background of experimental information concerning the volumetric and phase behavior of binary and ternary hydrocarbon systems is used as the basis for a comparison of these systems with naturally occurring hydrocarbon mixtures under conditions representative of underground petroleum reservoirs. The qualitative and semiquantitative similarities and differences between the two types of systems are considered in reference to the possibilities and limitations of using experimental data on binary and ternary systems for predicting the volumetric and phase behavior of naturally occurring hydrocarbon mixtures of low molecular weight. The possible influence on such phase behavior of water, hydrogen sulphide, nitrogen, and components of relatively high molecular weight is discussed.

INTRODUCTION

During the past two decades much effort has been devoted to the study of the volumetric and phase behavior of pure paraffin hydrocarbons and of binary and ternary mixtures of these compounds. Many of these studies were carried out with the direct objective of utilizing a knowledge of the detailed characteristics of binary and ternary mixtures of the lighter paraffin hydrocarbons for predicting the behavior of more complex mixtures. The ability to make such predictions with accuracy would be of great value in petroleum production and refining. Although the behavior of the methane-propane system[1] served at one time as a qualitative illustration of the probable characteristics of the more complex hydrocarbon mixtures found in nature, it fell far short of requirements for quantitative predictions. The present paper endeavors to indicate the relation of the more recently accumulated information concerning the behavior of binary and ternary hydrocarbons to this problem. In discussing binary and ternary systems as examples pointing toward the behavior of multicomponent systems no effort is made to present new methods of predicting the characteristics of natural hydrocarbon mixtures. Preliminary proposals have been made elsewhere for the prediction of volumetric[2,3,4], phase equilibrium[4,5,6,7], and thermodynamic[8,9,10,11] data for multicomponent mixtures, utilizing as a basis the behavior of binary and ternary systems. Numerous other proposals have been made. That based upon the concept of a pseudo-critical state[12] has proved to be of value to the petroleum industry.

Concurrently with this study of binary and ternary systems investigations have been made of natural hydrocarbon systems. Of the many publications reporting such experimental information only a few examples will be mentioned. A number of studies of black oil and natural gas have been made[13,14,15] and much attention has been directed to extended and detailed investigations of the behavior of fluids in condensate fields[16,17,18,19,20]. This work has been supplemented by some studies of the separation of bitumen from natural hydrocarbon liquids[21,22]. The over-all behavior of such systems has been used in predicting the volumetric and phase behavior of naturally occurring mixtures[23,24,25,26]. This background of experimental and correlated information concerning the behavior of multicomponent hydrocarbon systems also permits a direct comparison of the characteristics of binary and ternary aliphatic systems with those materials produced from underground reservoirs.

PRESENTATION OF DATA

The primary limitation encountered in using binary and ternary aliphatic hydrocarbon mixtures as examples of the characteristics of the fluids encountered in underground reservoirs lies in the existing lack of knowledge of the quantitative effect upon behavior of the presence of several important constituents, notably hydrocarbons of high molecular weight, water, carbon dioxide, hydrogen sulphide, and nitrogen. The presence of substantial quantities of hydrocarbons of fairly high molecular weight serves to increase the complexity of the phase behavior of natural systems. No simple systems yet studied give adequate guidance in this regard. The influence of such materials of high molecular weight was indicated earlier[23,27] to an extent which serves to show that definite limitations now exist in the correlation of simple and complex systems. However, significant progress is being made in filling gaps in the information. For example, similarities in the behavior of fluids in condensate fields with that of binary and ternary systems are becoming more systematically evident.

A few studies of the behavior of water in paraffin hydrocarbon systems have been made[27,28,29]. Results of investigations of mixtures of carbon dioxide and the lighter hydrocarbons also are available[30,31,32]. Limited work has been reported con-

Manuscript received at the Petroleum Branch Office February 22, 1949. Paper presented at the AIME annual meeting in San Francisco, February 13-17, 1949.

[1]References are given at end of paper.

cerning the solubility of hydrogen sulphide in liquids[33,34]. However, it appears that additional knowledge of the influence of hydrogen sulphide on the phase behavior of hydrocarbons must be obtained before its effect can be estimated with any surety.

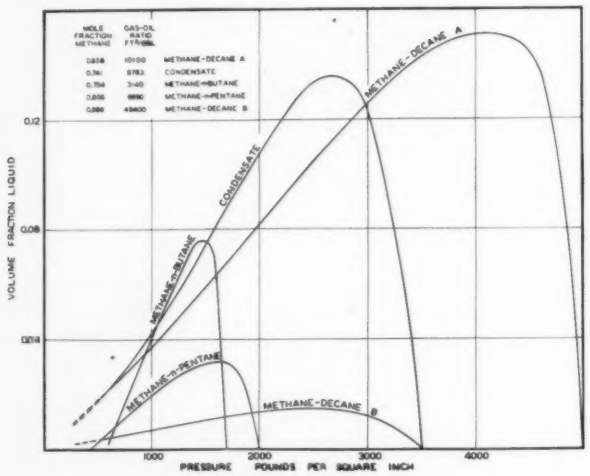


FIG. 1 — FRACTIONAL VOLUME OF LIQUID PHASE IN SEVERAL SYSTEMS AT 160°F.

It is often important to know the influence of changes in pressure upon the separation of liquid from the gas phase of a reservoir during production operations. Fig. 1 shows for several systems the fraction of the volume of the system that is occupied by liquid as a function of pressure for a temperature of 160°F. The data for the natural mixture are taken from direct laboratory measurements of the behavior of high-gravity oil and related gas from a San Joaquin Valley Field[19]. For comparison, curves showing the behavior of the methane - decane[35,36,37], the methane - pentane[38,39], and the methane-*n*-butane[40] systems are included. The gas-oil ratios*[19] of the binary mixtures are indicated and they are computed throughout this discussion on the basis that all the methane and ethane are considered to be "gas." A marked similarity of behavior appears between the multicomponent system and the binary systems. Suitable volumetric data for ternary systems have not yet been published and so no example could be included in Fig. 1. However, Fig. 2 shows the relative number of moles of liquid compared to the total moles constituting the system as found in several different ternary mixtures. These data relate to the methane-ethane-*n*-pentane system[41] and the methane-propane-*n*-pentane system[42,43], the compositions of the mixtures being expressed in terms of the mole fractions of the components and of the gas-oil ratio. The arbitrary method of designation of gas and oil described above was followed here. The behavior of mixtures of methane and *n*-pentane containing the same and a higher mole fraction methane shows distinct similarity to that of the ternary mixtures.

The component of intermediate molecular weight in a ternary mixture is one of interest because it is analogous to components of intermediate volatility in a natural system. Fig. 3 indicates the mole fraction of the intermediate component which is present in the gas phase with varying pressure for the several mixtures covered in Fig. 2. The ordinate in Fig. 3 is the fraction of the intermediate component in the system which is found in the liquid phase under the conditions indicated by the figure. The curves serve to illustrate the marked changes in this quantity as the pressure is progressively decreased. This information serves to illustrate the similarity in the behavior of ternary systems to the more complex naturally occurring hydrocarbon mixtures.

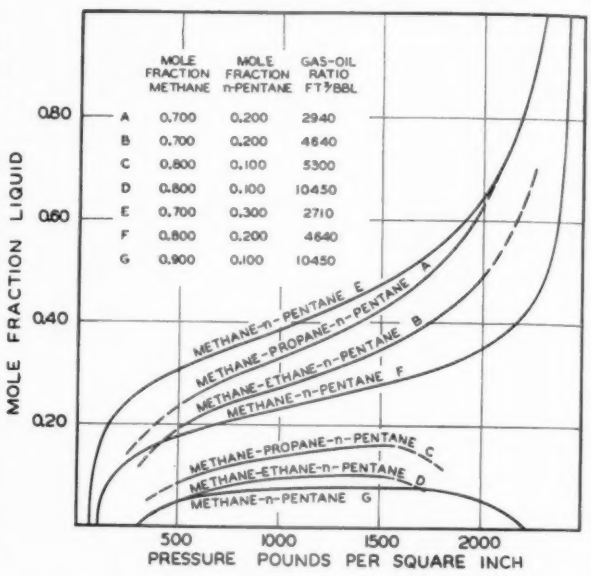


FIG. 2 — RELATIVE MOLAL QUANTITIES OF LIQUID PHASE FOR BINARY AND TERNARY MIXTURES CONTAINING METHANE AND *N*-PENTANE AT 100°F.

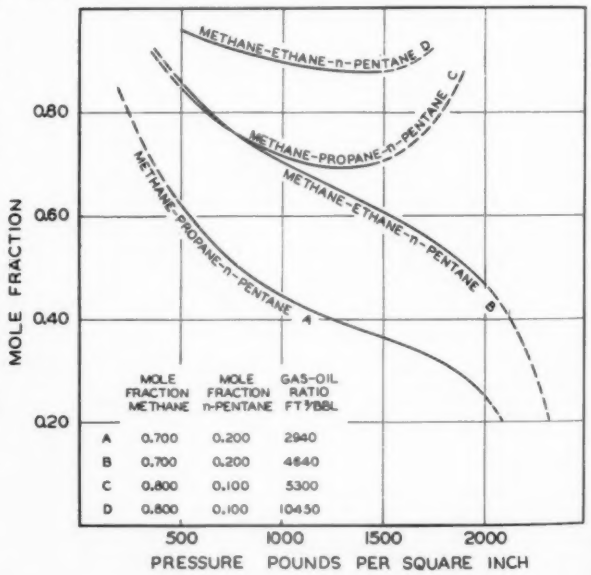


FIG. 3 — DISTRIBUTION OF COMPONENTS OF INTERMEDIATE VOLATILITY IN TERNARY SYSTEMS AT 100°F.

* For present purposes the gas-oil ratio is taken as the volume of "gas," measured in cubic feet at 60°F. and 30-in. of mercury pressure, associated with one barrel of oil measured under the same conditions.

The generalized equilibrium constants[5,44,45] which have been thus far published do not appear to be applicable at states approaching the retrograde dew point of the system. For this reason it is not possible to predict from them the distribution of components of intermediate volatility in naturally occurring mixtures corresponding to that shown for the ternary system in Fig. 3. However, as additional information, particularly that obtained from ternary and more complex systems, is employed, it will become feasible to make such calculations with reasonable accuracy for multicomponent systems. The data already available concerning the phase behavior of ternary systems[41,42,43] reflect the marked influence of the composition of the phases, as well as pressure and temperature, upon the equilibrium constants. This fact makes it evident that utilization of experimentally established equilibrium constants for a ternary system in making predictions will be much less convenient than if it were possible to consider the equilibrium constant to be a function of pressure and temperature only.

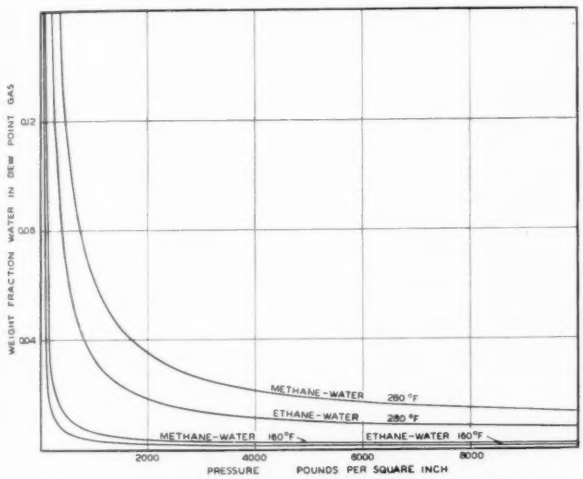


FIG. 4 — WEIGHT FRACTION WATER IN THE GAS PHASE IN THE METHANE-WATER AND ETHANE-WATER SYSTEMS.

In order to illustrate the extent to which water may occur in gas phases, Fig. 4 presents information concerning the compositions of the gas phase of the methane-water[27] and of the ethane-water[28] systems. In this diagram the weight fraction of water is shown as a function of pressure for the two binary systems at two temperatures. The weight of water in a cubic foot of gas space is shown in Fig. 5 as a function of pressure for 160° and 280°F.

Comparison of Figs. 4 and 5 shows that although the weight fraction of water in the gas phase decreases markedly with increase in pressure, nevertheless the amount of water in each cubic foot of gas space increases at higher pressures, the effect being large at the temperatures found in deep reservoirs. The condensation of water which would occur upon lowering of pressure and temperature during production of fluids from condensate fields would account for the fresh water frequently found in production traps. Because of the relatively small difference in behavior shown with methane and with ethane it is believed that for many practical purposes the curves shown in Fig. 5 may be used as a rough estimate of the behavior of natural hydrocarbon gas phases. In the

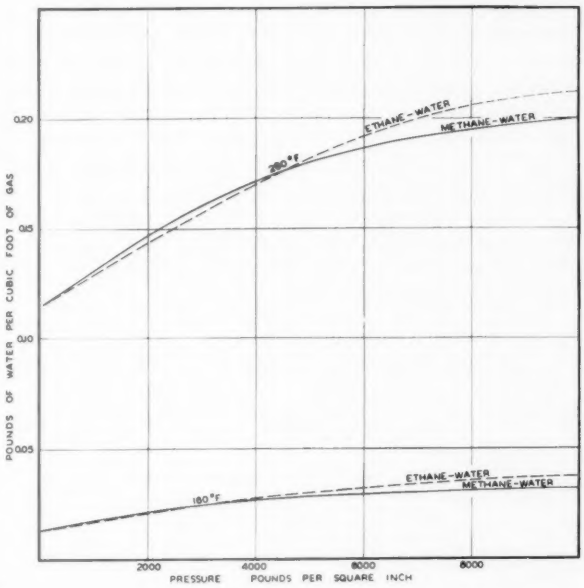


FIG. 5 — WATER IN A UNIT VOLUME OF GAS PHASE IN THE METHANE-WATER AND ETHANE-WATER SYSTEMS.

case of systems at equilibrium with salt water, the quantity of water in the gas phase will be slightly less than that shown in Figs. 4 and 5 because the fugacity of water in a saline solution at a given pressure and temperature is lower than that for pure water at the same conditions.

At low temperatures water-hydrocarbon systems form hydrates[46,47,48]. The temperatures found in most underground petroleum reservoirs are above those at which hydrates are stable. However, these solid phases are of importance in surface production operations and in the transmission of natural gas. It appears that reasonable agreement can be found between the characteristics of hydrates of the lighter paraffin hydrocarbons[46] and the behavior of hydrates prepared from multicomponent hydrocarbon mixtures[47,48]. In the latter case it

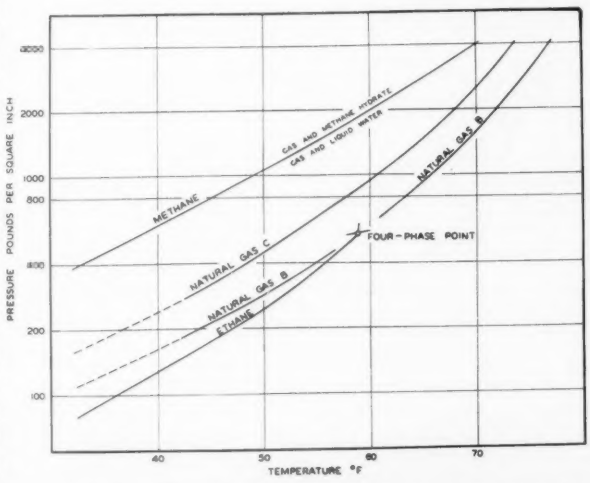


FIG. 6 — COMPARATIVE BEHAVIOR OF HYDRATES INVOLVING METHANE, ETHANE, AND A NATURAL GAS.

is probable that the hydrates are solid solutions and that decomposition or formation may occur over a range of temperature for a given pressure. Fig. 6 is a temperature-pressure diagram showing the behavior of the methane-water system, the ethane-water system, and a natural gas-water system under conditions where hydrates, hydrocarbon gas, and an aqueous phase coexist. Table 1 records the compositions of the natural gases represented in the figure. The similarity of the curves offers promise that a reasonable amount of additional data will suffice for predictions relating to multicomponent systems. Some steps in this direction have already been taken by Katz and his co-workers[47,48].

TABLE 1

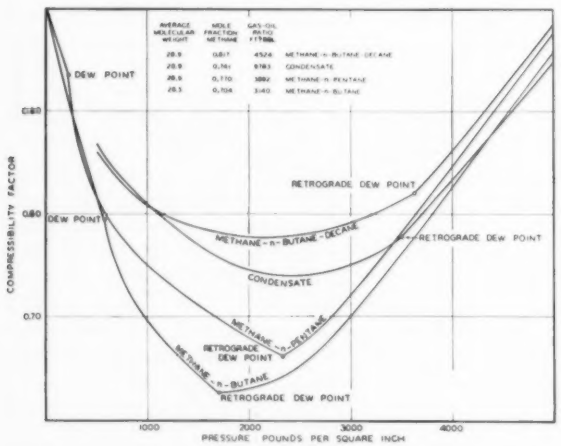
*Composition of Natural Gases**

Component	Mole Fractions Gas B	Gas C
Nitrogen	0.0064	0.0043
Carbon Dioxide	—	0.0051
Methane	0.8641	0.9320
Ethane	0.0647	0.0425
Propane	0.0357	0.0161
Isobutane	0.0099	—
n-Butane	0.0114	—
Pentane and all others	0.0078	—

Some of the similarities and differences of simple and complex hydrocarbon systems have been pointed out. An entirely satisfactory way to utilize the similarities for prediction purposes has yet to be found. If a simple characterization factor such as average molecular weight is used as a basis of comparison results such as are shown in Fig. 7 are obtained. In this figure the compressibility factors of four systems[19,20,48,49] of approximately the same average molecular weight are compared at 160°F. The compositions of these systems are given in Table 3. Although the curves bear a similarity they differ markedly from each other.

Consideration of different systems at the same reduced state has been proposed on the basis of pseudo-critical states for binary and multi-component systems[12]. Comparisons based upon the concept of a convergance pressure[50] have been made, but the evaluation of this quantity in advance of experimental measurements may prove difficult. Predictions from partial properties (such as the partial volume) of the various components and their proportions in the system depend upon a knowledge of the effect of composition environment as well as those of temperature and pressure upon the partial property values. Table 2 gives a comparison between the experimentally determined behavior[14] of a complex mixture and that predicted by a correlating method proposed by Brown[51]. Although the method requires extensive information it takes into account factors which have been shown to be pertinent. In any of these methods, prediction of behavior near the critical state of the system will be likely to have uncertainties.

One or more of the more elaborate equations of state[52,53,54] may be of particular utility in predicting the thermodynamic behavior of multicomponent mixtures from data relating to binary, ternary, and possibly more complex hydrocarbon systems. There appears to be a limit to the efficacy of graphical methods when applied to such problems. The advent of commercial digital computing equipment with some memory



F.G. 7 — COMPARISON OF VOLUMETRIC BEHAVIOR OF NATURAL MIXTURE WITH SEVERAL SIMPLE MIXTURES AT 160° F.

* Data obtained from published information[47]. Volumetric behavior of these gases shown in Fig. 6.

TABLE 2

Comparison of Observed and Calculated Compressibility Factors for Gas Samples from Santa Maria Valley Field†

Component	Composition Mole Fractions	100°F. Pressure PSI Absolute	Compressibility Factor Observed	Calculated‡
Methane	0.7511	1250	0.7231	0.742
Ethane	0.0959	1500	0.6874	0.710
Propane	0.0813	1750	0.6651	0.681
Isobutane	0.0124	2000	0.6544	0.674
n-Butane	0.0266			
Isopentane	0.0065			
n-Pentane	0.0060			
Carbon Dioxide	0.0140			
Hexanes and heavier	0.0062			

† Data obtained from published information[14].
‡ Calculated from published correlations[51].

TABLE 3

Compositions of Mixtures for Fig. 7

System	Component	Mole Fraction
Methane-*n*-Butane-Decane		
	Methane	0.817
	n-Butane	0.121
	Decane	0.062
Condensate		
	Methane	0.7406
	Ethane	0.0772
	Propane	0.0485
	Isobutane	0.0101
	n-Butane	0.0209
	Isopentane	0.0084
	n-Pentane	0.0091
	Hexanes	0.0151
	Heptanes and heavier	0.0606
	Carbon Dioxide	0.0095
Methane-*n*-Pentane		
	Methane	0.770
	n-Pentane	0.230
Methane-*n*-Butane		
	Methane	0.704
	n-Butane	0.296

features appears to afford an avenue of approach to the prediction of the characteristics of multicomponent hydrocarbon mixtures at individual states of interest at a particular time. After nearly two decades of fairly intense experimental effort by a number of laboratories, the background of experimental information is nearly sufficient for the establishment of the characterization coefficients of equations of state which can be effectively utilized in predicting the behavior of naturally occurring mixtures. At present such methods cannot be extended accurately to mixtures involving large quantities of the heavier hydrocarbons nor can they deal with cases involving formation of solid or plastic bitumen phases or solid hydrates.

ACKNOWLEDGMENT

The assistance of Hugh Johnson and Elizabeth Kendall in connection with calculations and of Ann Jarvis in the preparation of the figures is acknowledged.

REFERENCES

1. Sage, Lacey, and Schaafsma: *Oil and Gas Jnl.* (1933) **32,** 12.
2. Sage, Hicks, and Lacey: Amer. Petr. Inst. *Drill. and Prod. Prac.*, 1938 (1939) 402.
3. Sage and Lacey: *Refiner and Nat'l. Gasoline Mfr.* (1939) **18** (11) 88. *Oil and Gas Jnl.* (1939) **38** (27) 189. Amer. Petr. Inst. *Drill. and Prod. Prac.*, 1939 (1940) 641.
4. Sage and Lacey: Amer. Petr. Inst. *Drill. and Prod. Prac.*, 1941 (1942) 308.
5. Sage, Hicks, and Lacey: Amer. Petr. Inst. *Drill. and Prod. Prac.*, 1938 (1939) 386. *Refiner and Nat'l. Gasoline Mfr.* (1938) **17**, 350.
6. Sage and Lacey: *Calif. Oil World* (1941) 16, 31.
7. Sage and Lacey: *Ind. Eng. Chem.* (1938) **30,** 1296.
8. Sage, Olds, and Lacey: Amer. Petr. Inst. *Drill and Prod. Prac.*, 1942 (1943) 162.
9. Holcomb and Brown: *Ind. Eng. Chem.* (1942) **34,** 590.
10. Maron and Turnbull: *Ind. Eng. Chem.* (1942) **34,** 544.
11. Edmister: *Petroleum Refiner* (1947, 1948) **46** and **47** (series).
12. Kay. *Ind. Eng. Chem.* (1936) **28,** 1014.
13. Sage and Reamer: AIME Tech. Pub. No. 1251; *Petroleum Technology*, November 1940. *Trans.* AIME (1941) **142,** 179.
14. Olds, Sage, and Lacey: AIME Tech. Pub. No. 1588; *Petroleum Technology*, March 1943.
15. Sage, Lacey, and Schaafsma: *Ind. Eng. Chem.* (1935) **27,** 162.
16. Eilerts: *Oil and Gas Jnl.*, February 1, February 8, and February 15, 1947.
17. Eilerts, Barr, Mullens, and Hanna: *Petroleum Engineer*, February 1948.
18. Olds, Sage, and Lacey: AIME Tech. Pub. No. 1861; *Petroleum Technology*, May 1945.
19. Olds, Sage, and Lacey: AIME Tech. Pub. No. 2412; *Petroleum Technology*, September 1948.
20. Sage and Olds: AIME Tech. Pub. No. 2153; *Petroleum Technology*, March 1947.
21. Botkin, Reamer, Sage, and Lacey: Amer. Petr. Inst. *Fundamental Research on Occurrence and Recovery of Petroleum*, 1944-45 (1946) 42.
22. Botkin, Reamer, Sage, and Lacey: Amer. Petr. Inst. *Fundamental Research on Occurrence and Recovery of Petroleum*, 1943 (1944) 62.
23. Standing: *Oil and Gas Jnl.* (1947) **46** (2) 95, 100.
24. Technical Committee, Natural Gasoline Association of America: *Ind. Eng. Chem.* (1932) **34,** 1240.
25. Standing and Katz: AIME Tech. Pub. No. 1323; *Petroleum Technology*, July 1941.
26. Katz and Hachmuth: *Ind. Eng. Chem.* (1937) **29,** 1072.
27. Olds, Sage, and Lacey: *Ind. Eng. Chem.* (1942) **34,** 1223.
28. Reamer, Olds, Sage, and Lacey: *Ind. Eng. Chem.* (1943) **35,** 790.
29. Reamer, Olds, Sage, and Lacey: *Ind. Eng. Chem.* (1944) **36,** 381.
30. Katz and Poettman: *Ind. Eng. Chem.* (1946) **38,** 330.
31. Reamer, Olds, Sage, and Lacey: *Ind. Eng. Chem.* (1944) **36,** 88.
32. Reamer, Olds, Sage, and Lacey: *Ind. Eng. Chem.* (1945) **37,** 688.
33. Frolich, Touch, Hogan, and Peer: *Ind. Eng. Chem.* (1931) **23,** 548.
34. Wright and Maass: *Canadian J. Research* (1932) **6,** 94.
35. Lavender, Sage, and Lacey: *Oil and Gas Jnl.* (1940) **39** (9) 48.
36. Sage, Lavender, and Lacey: *Ind. Eng. Chem.* (1940) **32,** 743.
37. Reamer, Olds, Sage, and Lacey: *Ind. Eng. Chem.* (1942) **34,** 1526.
38. Taylor, Wald, Sage, and Lacey: *Oil and Gas Jnl.* (1939) **38** (10) 46.
39. Sage, Reamer, Olds, and Lacey: *Ind. Eng. Chem.* (1942) **34,** 1108.
40. Sage, Hicks, and Lacey: *Ind. Eng. Chem.* (1940) **32,** 1085.
41. Billman, Sage, and Lacey: AIME Tech. Pub. No. 2232; *Petroleum Technology*, July 1947.
42. Carter, Sage, and Lacey: *Trans.* AIME (1941) **142,** 170.
43. Dourson, Sage, and Lacey: *Trans.* AIME (1943) **151,** 206.
44. Smith and Wilson: *Trans.* Am. Inst. Chem. Engrs. (1946) **42,** 5 and 927.
45. Hadden: *Chem. Eng. Prog.* (1948) **44** (1) 37 and (2) 135.
46. Roberts, Brownscombe, and Howe: *Oil and Gas Jnl.*, Dec. 5, 1940.
47. Wilcox, Carson, and Katz: *Ind. Eng. Chem.* (1941) **33,** 662.
48. Carson and Katz: AIME Tech. Pub. No. 1371; *Petroleum Technology* 1941.
49. Reamer, Sage, and Lacey: *Ind. Eng. Chem.* (1947) **39,** 77.
50. Hanson and Brown: *Ind. Eng. Chem.* (1945) **37,** 821.
51. Brown: *Deviation of Natural Gas from Ideal Gas Laws.* Clark Bros., Inc., Olean, New York (1940).
52. Beattie and Bridgeman: *Proc. Amer. Acad. Arts and Sciences* (1928) **63,** 229.
53. Benedict, Webb, and Rubin: *Jour. of Chem. Physics* (1940) 8 (4) 334.
54. Gouq-Jen Su and Chien-Hou Chang: *Ind. Eng. Chem.* (1946) **38,** 802.

★ ★ ★

T.P. 2641

INTRODUCTION TO INDUCTION LOGGING AND APPLICATION TO LOGGING OF WELLS DRILLED WITH OIL BASE MUD

H. G. DOLL, MEMBER AIME, SCHLUMBERGER WELL SURVEYING CORP., HOUSTON, TEXAS

ABSTRACT

A new logging method, called induction logging, is described; it measures the conductivity, or resistivity, of the strata traversed by a bore hole. The apparatus, which is briefly described, comprises a coil system coupled with the ground by induction, so that there is no need for direct contact with the mud, or with the formations. For that reason, the method is particularly useful in oil base mud, and it was first applied to that case.

A discussion concerning the respective contribution of each region of ground in the vicinity of the coil system is given. Through the concept of a geometrical factor, it is demonstrated that the total signal, which measures the apparent conductivity, is the summation of the partial products — geometrical factor by conductivity — for the different regions of the ground under consideration. It is thus possible to establish, for each type of coil arangement, investigation characteristic as well as departure curves and correction charts for beds of various thicknesses. This should greatly facilitate the quantative interpretation of the field logs, even in cases where such interpretation would have been difficult on electric logs taken with electrodes.

It is also shown that focussing combinations of coils can be used, which give, directly on the recorded log, a value close to the true conductivity, even for fairly thin beds, thus eliminating in most cases the need for corrections. These focussing systems also give a sharper definition of the boundaries between successive strata.

Manuscript received at Petroleum Branch Office February 7, 1949. Paper presented at AIME Annual Meeting in San Francisco February 13-17, 1949.

[1]Reference given at end of paper.

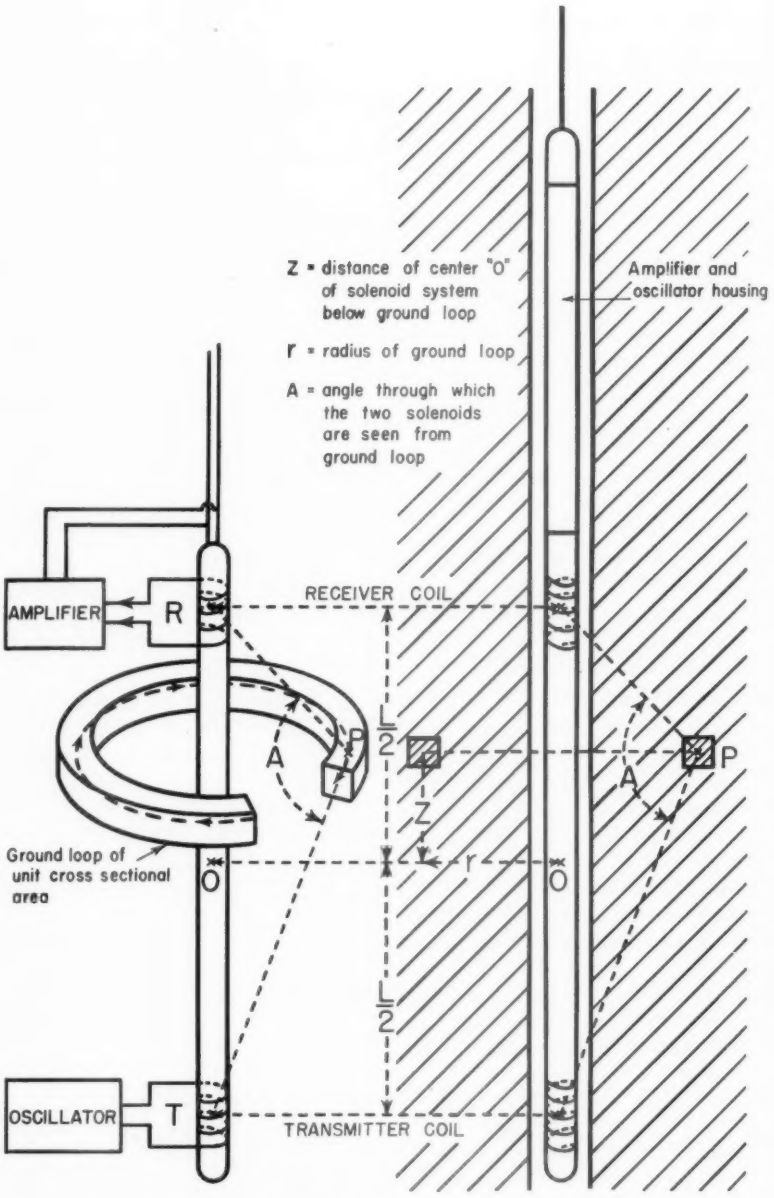


FIG. 1 — A (LEFT) B (RIGHT) SCHEMATIC DRAWINGS OF APPARATUS USED FOR INDUCTION LOGGING.

INTRODUCTION

The measurement of the resistivity of the different formations traversed by drill holes has become standard practice in oil well drilling during the last 20 years. The technique used requires that direct contact be made with the mud filling the bore hole by means of electrodes which are connected to the insulated conductors of the supporting cable. A current of constant intensity is generally made to flow in the surrounding medium, by ohmic effect, potential differences which are proportional to its average resistivity. These potential differences, as picked up by one or more measuring electrodes in the bore hole, are recorded continuously at the surface of the ground, giving the resistivity log.

There are cases, however, where a direct contact between the electrodes and the drilling mud is not possible, for instance, in holes drilled with cable tools, which are generally dry, or in holes where non-conductive oil base mud is used in rotary drilling. The conventional electrical logging method then requires scratcher electrodes, which are forced by springs on the walls of the hole, to make direct contact with the formations. In some cases, the results are fairly satisfactory, but sometimes, particularly in wells drilled through hard formations, the measurements are not reliable because of poor contacts with the formations. It is, in particular, to surmount these problems that a new method of electrical logging, known as induction logging, has been introduced for resistivity measurements in oil base mud.

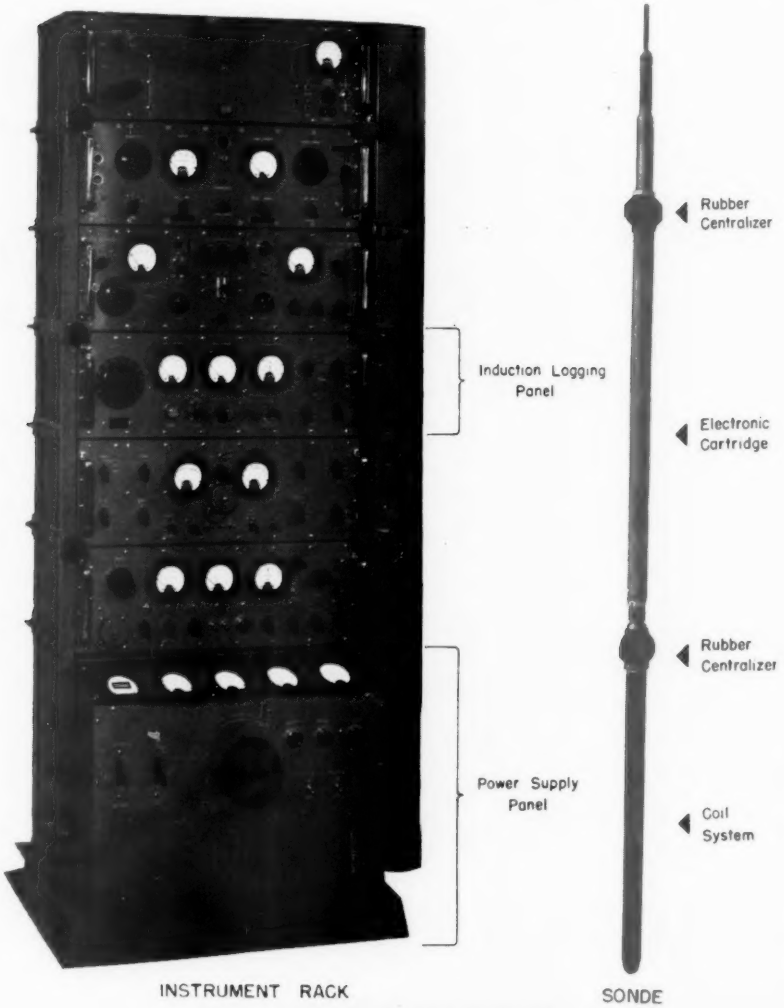


FIG. 2 — INDUCTION LOGGING EQUIPMENT.

The induction logging system does not require any direct contact with the mud, or with the ground. As indicated by the name of the method, the formations surrounding the logging apparatus are energized by induction. To that effect, alternating current of appropriate frequency is made to flow through a coil, referred to as a "transmitter", which is supported by an insulating mandrel. The alternating magnetic field thus created generates eddy currents, which currents follow circular paths, coaxial with the coil system and the hole, in the formations surrounding said hole. These eddy currents create a secondary magnetic field which induces an electromotive force in a second coil, referred to as a "receiver", mounted on the same nonductive mandrel at a certain distance, called "spacing", from the transmitter.

If the transmitter current is maintained at a constant value, the intensity of the eddy currents is proportional to the conductivity of the ground. Thereby, the conductivity of the ground determines the secondary field created by the eddy currents, and the signal generated in the receiver.

As in regular logging with electrodes, the signal is recorded continuously at the surface of the ground while the apparatus is moved along the hole. The record thus produced, which is frequently called an "induction log", because of the way in which it is obtained, shows the variations of the ground conductivity — and, consequently, of its inverse, the ground resistivity — with respect to depth. It is, therefore, equivalent to the resistivity log obtained by the conventional method of electrical logging with electrodes in water base mud.

The present paper is limited to the theory of the induction logging method, and to considerations concerning its application in holes drilled with oil base mud. In so doing, the paper simply follows the industrial development of this new technique to meet the challenge introduced by the use of oil base mud. In that case, the advantages of the method are more immediate, especially in view of the difficulties encountered by the conventional method of electrical logging. This does not mean that the induction logging method will not work in water base mud; on the contrary, it is believed that, in that case also, the

method will have important advantages. Experience in water base mud is, however, still very limited, not only because the available instruments were all applied to oil base mud operations, where they were urgently needed, but also because certain improvements, which are still being studied, are to be introduced for best operation in water base mud. This is why it was felt advisable not to discuss the use of induction logging in water base mud at this time, and to wait for the results of field tests that will be made for that case.

Notation:

In the present paper, the following notation is used, in which "C" represents conductivity and "R" represents resistivity.

$C_t = \frac{1}{R_t}$ = true conductivity of a bed.

$C_i = \frac{1}{R_i}$ = conductivity of the zone invaded by mud filtrate in a permeable bed.

$C_m = \frac{1}{R_m}$ = conductivity of the drilling mud, which is considered as negligible in the case of oil base mud.

$C_{sa} = \frac{1}{R_{sa}}$ = apparent conductivity of the formations surrounding, or adjacent to, a bed.

In logging practice, the resistivity unit is the ohm-meter. Conductivities are expressed in mhos per meter. It is preferred, however, to use units of millimhos per meter for induction logging in order to get a range of values that does not require extensive use of decimal figures. Accordingly,

$$C \text{ mmhos/m} = \frac{1000}{R \text{ ohm-m}}$$

Thereby, a bed with a resistivity of 100 ohm-m has a conductivity of 10 mmhos/m.

PRINCIPLE OF RESISTIVITY MEASUREMENTS BY INDUCTION LOGGING

The apparatus used for induction logging is shown schematically on Figs. 1A and 1B; it is, in fact, a mutual impedance bridge. It comprises essentially a transmitter coil T, fed with alternating current by an oscillator, and a receiver coil R connected through an amplifier to the recording galvanometer. In the absence of any conductive medium around the apparatus, as, for example, when it is suspended in the air from a wood frame high enough above ground, the coupling between the transmitter and receiver coils is fully balanced, so that the measuring apparatus reads zero. When the apparatus is in a drill hole, the alternating field set up by the transmitter coil produces in the surrounding medium — i.e., in the ground — induced currents, generally known as "eddy currents", which are proportional to the conductivity of the ground. The electromotive force induced in the receiver coil by the eddy currents, referred to hereafter as "the signal", and designated by the letter E, is proportional to the conductivity of the ground. If, therefore,

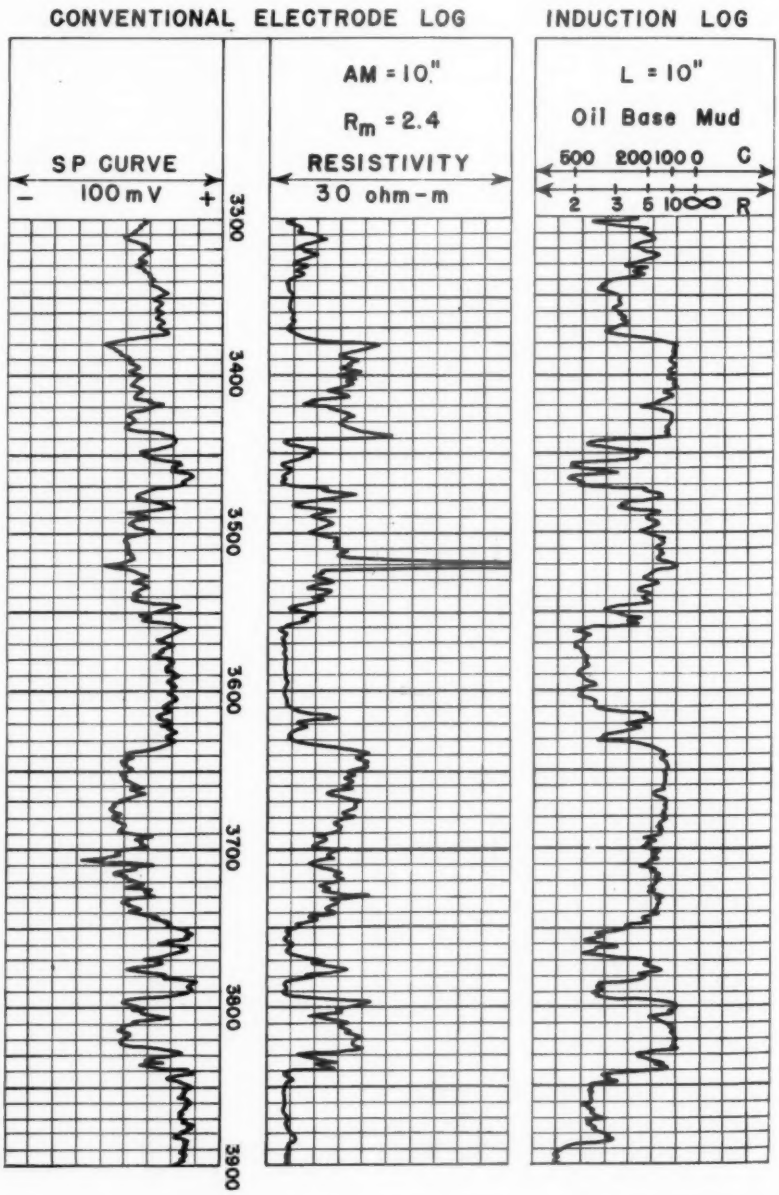


FIG. 3 — COMPARISON OF CONVENTIONAL ELECTRIC LOG IN WATER BASE MUD AND INDUCTION LOG IN OIL BASE MUD.

the apparatus is properly calibrated, a measure of the signal constitutes a quantitative determination of the conductivity* of the ground.

The signal is amplified and rectified into direct current for transmission in the cable to the surface where it is automatically recorded. A remote controlled test signal is provided in the apparatus to check the calibration.

The oscillator and the amplifier are contained in a pressure-proof housing, called the electronic cartridge, on top of the coil assembly. The subsurface instrument is represented schematically in Fig. 1B. A photograph of the equipment used for induction logging is shown in Fig. 2, where the sonde corresponds to Fig. 1B. An induction log recorded in oil base mud by this equipment is given on Fig. 3, alongside the conventional electric log of the same well recorded later in water base mud for comparison.

When the ground surrounding the coil system is homogenous, as is practically the case for a thick bed which is not appreciably invaded by the mud fluid, the conductivity C_a, as measured by the apparatus, is substantially equal to the true conductivity C_t of the ground. When, however, the ground around the coil system is not homogenous, as for example, in the case o fa thin bed surrounded by formations of appreciably different conductivity, the conductivity C_a, as measured by the apparatus, represents a combination of the conductivities of the different media surrounding the coil system, and is referred to as the "apparent conductivity." This is similar to what happens for electrical logging with electrodes where the apparatus also measures an apparent resistivity, R_a. In both cases, a better approximation of the true conductivity can be obtained by applying corrections deduced from the departure curves* or correction charts.

As will be explained in more detail later in this paper, an important advantage of the induction logging system is that the measured values, even without corrections, are already nearer to the true values; furthermore, the corrections themselves are much easier to compute than in the case of logging with electrodes, particularly when influence of bed thickness is to be taken into consideration.

* The words "conductivity" and "resistivity" are used indifferently in this paper both in the text and in the charts, inasmuch as one quantity is the inverse of the other.

* Departure curves for electrical logging with electrodes have been published earlier in a booklet entitled "Resistivity Departure Curves," 1947, by Schlumberger Well Surveying Corporation, Houston, Texas. The application of the curves was discussed in a paper on "True Resistivity Determination from the Electric Log — Its Application to Log Analysis," by H. G. Doll, J. C. Legrand and E. F. Stratton, presented at the Spring Meeting, 1947, of the Pacific Coast District at Los Angeles, California, Division of Production, American Petroleum Institute.

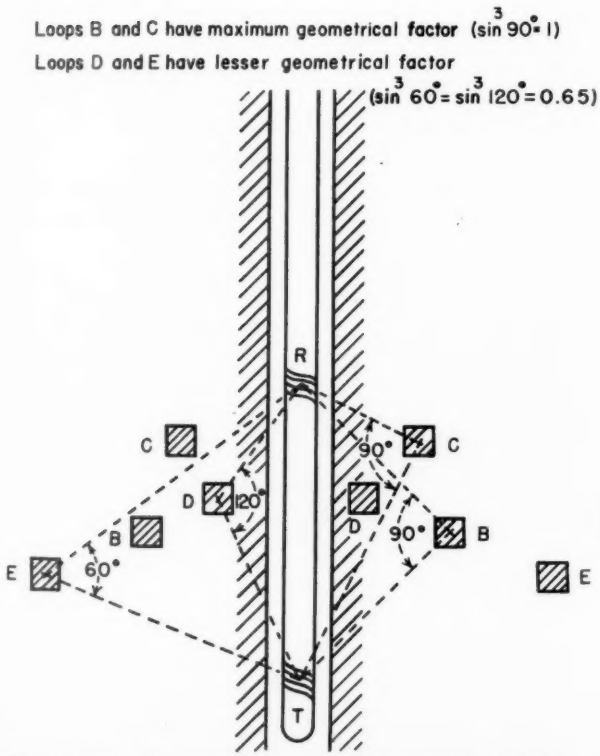


FIG. 4A — THE UNIT GROUND LOOP AND ITS GEOMETRICAL FACTOR.

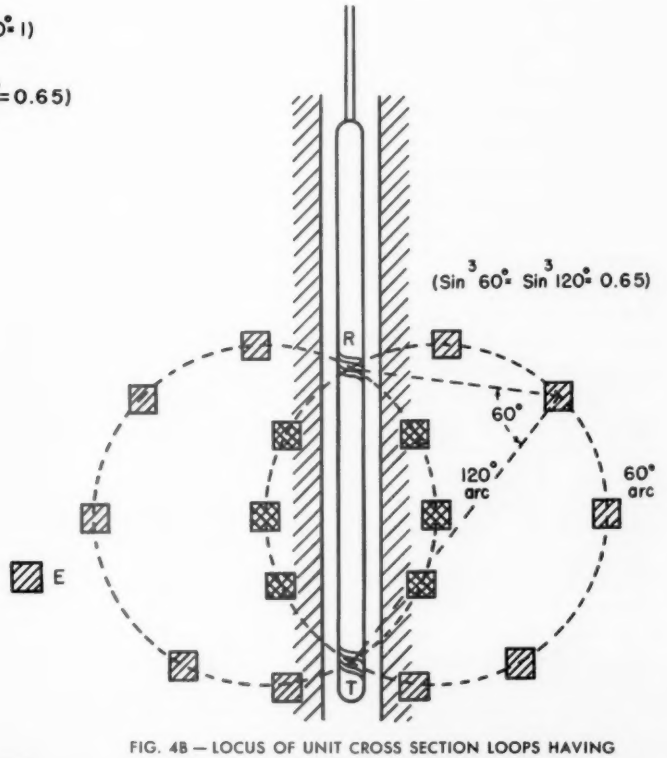


FIG. 4B — LOCUS OF UNIT CROSS SECTION LOOPS HAVING EQUAL GEOMETRICAL FACTOR.

THE GEOMETRY OF INDUCTION LOGGING—RESPECTIVE INFLUENCE OF THE DIFFERENT REGIONS OF THE GROUND SURROUNDING THE COIL SYSTEM

In the logging method using electrodes for the determination of the ground resistivity, the flow of current is of the radial type, and it is not possible to study separately the influence of the different regions of ground surrounding the electrode system. The reason is that the lines of current flow cross the boundaries between the different media, such as, for example, the boundary between the mud and a bed. If the resistivity of any given medium is changed, this affects the lines of current flow even in their path through the other media. This is why the mathematical computation of departure curves is rather complicated, and can only lead to a fair approximation as soon as the beds are neither very thick nor homogenous.

In the induction logging, the situation is entirely different. If the hole is vertical, as will be assumed to simplify the discussion, the lines of current flow are horizontal circumferences having their center on the axis of the hole. Since there is generally a symmetry of revolution of the ground around the axis of the drill hole, each line of current flow remains in the same medium all along its path, and never crosses a boundary between media of different conductivities. On the other hand, and provided that the frequency is not too high, the reaction of the different circular currents on each other can be neglected. In this condition, the action of the different regions of ground, which individually have a symmetry of revolution around the hole, can be considered separately, and the measured signal is simply the sum of the individual signals given by the different regions. The consequence is that the theoretical computation of charts or of typical logs, corresponding to any distribution of ground conductivities, is always possible, provided, of course, that there be a symmetry of revolution, as is practically the case, and particularly so when the dip of the formations is small.

In the discussion that follows, use will be made of charts representing the cross section of the ground intercepted by a vertical plane containing the axis of the hole. Each "region" of ground—which means here a volume of ground having a symmetry of revolution around the hole — will be represented on such charts by its cross section by the plane of the figure, and these sections will be identified by letters like A, B, etc. . . . or otherwise. To simplify the wording, reference will be made, for instance, to the contribution of "section A" to the total signal; this will, of course, have to be construed as meaning the contribution of "region A", represented on the figure by "section A." This being stated, it becomes easy to discuss the contribution of a "section" of ground (meaning that of the corresponding volume or "region"). This contribution is a function of the area of the section and of a certain "geometrical factor" defined hereinafter, which factor depends on the position of the section with respect to the coil system.

All the mathematical computations, whose results are given in a later section, have been made with the assumption that the dimensions of the coils are small with respect to the diameter of any ground loop whose influence it is proposed to determine. This assumption, which simplifies substantially the mathematical work, is certainly reasonable and leads to quantitative values that can be considered as accurate for all practical purposes.

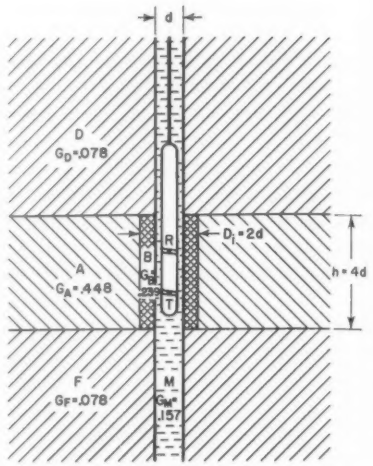


FIG. 5 — EXAMPLE OF RELATIVE VALUES OF GEOMETRICAL FACTOR (TWO-COIL SONDE; SPACING = 1.25 HOLE DIAMETER).

The characteristics of the electronic circuit adopted as such that only the resistive component of the signal is measured, i.e., the component of the e.m.f. in the receiver which is in phase with the current in the transmitter. The theoretical discussion that follows is based on formulae which, theoretically, apply only to low frequencies, but which are still sufficiently accurate, for all practical purposes, at the frequency of 20 kilocycles presently used.

The Unit Ground Loop and Its Geometrical Factor

By definition, the expression unit ground loop, as used in this paper, will

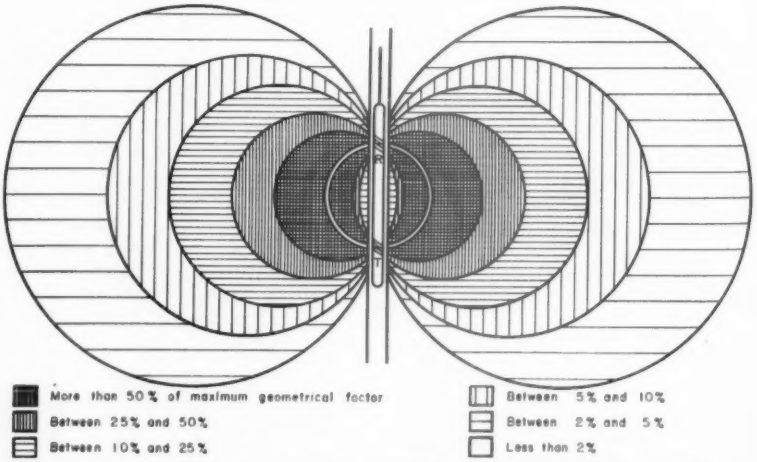


FIG. 6 — CHART OF THE GEOMETRICAL FACTOR FOR THE DIFFERENT REGIONS OF GROUND AROUND THE COIL SYSTEM.

mean a horizontal loop of homogeneous ground, having a circular shape with its center on the axis of the hole, and whose cross section is a very small square of unit area. Such a loop is represented schematically on Figs. 4A and 4B.

A unit ground loop of radius r, and situated at an altitude z with respect to the center 0 of the coil system, contributes to the signal E an elementary signal e given by:

$$e = K\ g\ C \quad . \ . \ . \quad (1)$$

in which C is the conductivity of the unit ground loop, and K an apparatus constant given by:

$$K = \frac{16\ \pi^3\ f^2\ A_T\ A_R\ I}{L} \quad . \quad (2)$$

with:

- f = frequency.
- A_T = area of transmitter coil, i.e., area of one turn multiplied by number of turns.
- A_R = area of receiver coil.
- I = intensity of current in transmitter coil.
- L = spacing between the two coils.

The factor g depends exclusively on the geometry, that is on the dimension and position of the unit loop. For that reason, it will be referred to as the "geometrical factor" of the unit loop, or as the "unit geometrical factor". The value of g, as a function of r and z, is given by:

$$g = \frac{L}{2} \frac{r^3}{\left[r^2 + \left(\frac{L}{2} - z\right)^2\right]3/2 \left[r^2 + \left(\frac{L}{2} + z\right)^2\right]3/2} \quad . \ . \ . \ . \ . \ . \ . \quad (3)$$

with:

- r = radius of the unit loop.
- z = altitude of the unit loop with respect to the center O of the coil system.
- L = spacing between the two coils.

A coefficient $\frac{L}{2}$ has been introduced into formula (3) in order that the integration of g throughout the entire section of the vertical plane be non-dimensional and normalized to unity.

Using these relations, the signal E corresponding to the whole space, as measured by the apparatus, is given by:

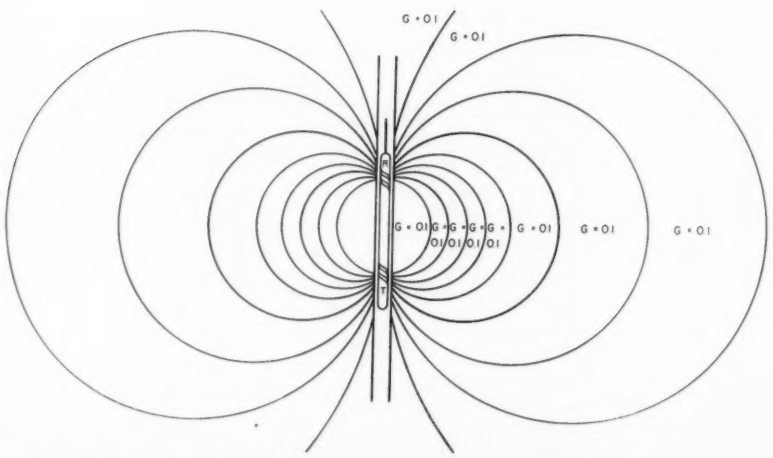
$$E = K \iint g\ C\ dr\ dz \quad . \ . \quad (4)$$

in which g and C are both functions of r and z. The limits for the radii of the unit loops range from zero to infinity, while the altitude of the loops range from an infinite distance below to an infinite distance above the center of the coil system.

In those cases where the space around the coil system can evidently be considered as made up of definite, though different, homogeneous regions A, B, D, - - -, the above expression (4) becomes:

$$E = K\ [C_A \iint_A g\ dr\ dz + C_B \iint_B g\ dr\ dz + - - -] \quad . \ . \ . \ . \ . \ . \quad (5)$$

in which C_A, C_B, - - - are the respective conductivities of the regions A, B, - - - .


G • 01
G • 01
G • 01

what proportion of the whole signal is contributed by that section, it is necessary to take into account the respective conductivities of the different sections, as is evident from relation (9) above. It can, in fact, very well happen that a region having only a small geometrical coefficient has a great influence on the measurement, simply because it has a proportionally large conducitivity. This would, for instance, be the case for the beds D and F of Fig. 5 where their conductivity is much higher than that of bed A whose conductivity the system is supposed to measure.

Detailed Study of the Geometrical Factor

It is interesting at this point to consider in more detail the geometrical factors, starting with that of the unit loop. Instead of expressing factor g as a function of r and z, as in relation (3), this unit geometrical factor can also be related to an angle A (see Figs. 1A and 1B) through which the two coils T and R are seen from a point P of the unit loop. This relation is:

$$g = \frac{\sin^3 A}{2L^2} \quad . \quad . \quad . \quad . \quad (12)$$

which can be easily deduced from (3). It shows that all unit loops for which the angle A has the same sine have the same geometrical factor, and, therefore, contribute the same amount to the total signal, provided, of course, that they have the same conductivity. On a figure representing a cross section of the ground by a plane containing the axis of the hole, all the unit loops having the same g are, therefore, on a circumference which passes through the centers T and R of the two coils. Such a circumference, corresponding to loops for which the angle A is either 60° or 120°, with the sine equal to 0.866 in both cases, is represented on Fig. 4B. The g is maximum for unit loops such as B or C on Fig. 4A, for which the angle A is 90°. The cross sections of such horizontal loops by the plane of the figure lie on a vertical circumference having TR for diameter.

The chart of Fig. 6 illustrates a certain number of the circumferences corresponding, respectively, to a given value of g. The circumference (in white) having TR for diameter corresponds to the maximum possible value for g which is used as reference. The other circumferences correspond to g's which are, respectively, 50%, 25%, 10%, 5% and 2% of the maximum g. This chart gives a good idea of the depth of investigation of the induction logging system, or, more generally, of the relative extent of that investigation.

As indicated by relation (7), the geometrical factor G_A depends not only on the average unit geometrical factor g for that region, but also depends to a large extent on the the area of its section. This is well illustrated by Fig. 7, which corresponds to Fig. 6. In Fig. 7, however, the space has been divided into

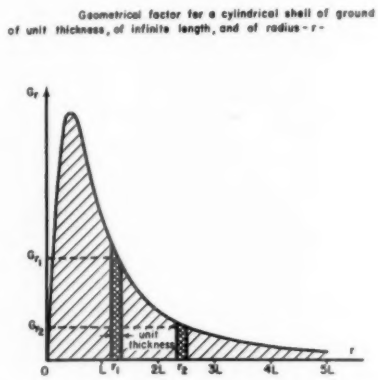


FIG. 8 — RADIAL INVESTIGATION CHARACTERISTIC FOR A TWO-COIL SYSTEM (L = SPACING = DISTANCE BETWEEN COILS.

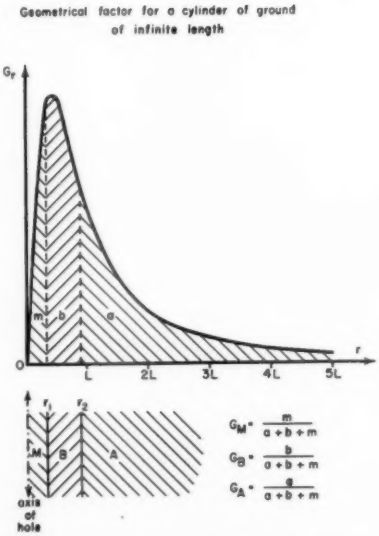


FIG. 9 — RADIAL INVESTIGATION CHARACTERISTIC (TWO-COIL SYSTEM SPACING "L").

ten sections having the same geometrical factor. In the case of ground with the same conductivity throughout, each of these sections contributes 1/10 of the total signal.

In order to study the lateral investigation qualities of the induction logging system and the effect of formations adjacent to the bed under investigation, it is convenient to divided the space either into cylindrical shells or into thin horizontal beds. The features of these aspects will be discussed in the following paragraphs.

Geometrical Factor of a Unit Cylindrical Shell; Lateral Investigation Characteristic

In a bed of great thickness, which might be invaded laterally up to a certain radius by mud fluid, the conductivity does not vary along the vertical, but it varies along the radius. Such a medium can be considered as the combination of a large number of cylinders, coaxial with the hole, which are individually homogeneous, but whose conductivity may vary from one cylinder to another. To study that case, it is advantageous to divide the space into an infinite number of cylinderical shells, coaxial with the hole, having unit thickness, referred to hereafter as "unit cylinders", and to determine the geometrical factor of each of these cylindrical shells as a function of its radius. This geometrical factor for each cylindrical shell of radius r, designated by G_r, is related to g by the following equation:

$$G_r = \int_{-\infty}^{+\infty} g \, dz \quad . \quad . \quad . \quad (13)$$

The integration of (13) does not lead to a simple expression for G_r, but gives, however, the following relation which permits the computation of G_r by means of tabulated elliptic integrals:

$$G_r = \frac{1}{2L} \frac{u}{(u^2+1)^2} \left[(u^2+3)\ (\sqrt{u^2+1}-1)\ K\ (\sin a) - (u^2-1)\ (\sqrt{u^2+1}+1)\ E\ (\sin a) \right] \quad . \quad . \quad . \quad . \quad (14)$$

where:

$$u = \frac{2r}{L} \quad . \quad . \quad . \quad . \quad (15a)$$

$$\sin a = 2\sqrt[4]{u^2+1}\ \sqrt{\frac{u^2+1-1}{u^2}} \quad . \quad (15b)$$

while K and E are the elliptical functions defined by:

$$K(\sin a) = \int_0^{\frac{\pi}{2}} \frac{d\theta}{\sqrt{1-\sin^2 a \sin^2 \theta}}$$

$$E(\sin a) = \int_0^{\frac{\pi}{2}} \sqrt{1-\sin^2 a \sin^2 \theta}\, d\theta$$

for which the numerical values can be found in tables of functions.[1]

The value of G_r, as a function of r, has been computed by the above relation (14), and it is represented by the curve of Fig. 8, which will be referred to as the "radial investigation characteristic." This curve shows the relative contribution of the different cylinders of ground in the case of a thick bed of uniform conductivity.

It is now easy to determine the relative values of the geometrical factor opposite a permeable bed. The geometrical factors for the regions indicated in Fig. 9 are, respectively, proportional to the corresponding areas m, b and a under the radial investigation characteristic. For reasons of normalization, the geometrical factor for the whole space is taken as a unity, so that G_M, G_B and G_A are really given by:

$$G_M = \frac{m}{m+b+a} \quad . \ . \ . \quad (17a)$$

$$G_B = \frac{b}{m+b+a} \quad . \ . \ . \quad (17b)$$

$$G_A = \frac{a}{m+b+a} \quad . \ . \ . \quad (17c)$$

Geometrical Factor of a Unit Horizontal Bed; Vertical Investigation Characteristic

When the induction logging system is located opposite a bed of finite thickness, the signal it measures is primarily responsive to the conductivity of that bed. In many cases, however, and in particular when the bed is rather thin and is surrounded by more conductive formations, the signal is quite appreciably influenced by these adjacent formations; in such instances, the apparent conductivity C_a, as measured, does not coincide with the true conductivity C_t of the bed under investigation.

To study that effect, it is convenient to disregard the effect of the mud column and the effect of mud filtrate penetration. The space can then be divided into an infinite number of horizontal beds of unit thickness, referred to hereafter as unit beds, individually characterized by their altitude with respect to the center of the coil system. The geometrical factor of such a unit bed, designated by G_z, is related to its altitude z by the following equation:

$$G_z = \int_0^\infty g\, dr \quad . \ . \ . \ . \quad (18)$$

The integration of (18) gives for G_z the following relations:

$$G_z = \frac{1}{2L} \quad \text{when} \quad -\frac{L}{2} < z < +\frac{L}{2} \quad . \ . \ . \ . \ . \quad (19a)$$

$$G_z = \frac{L}{8z^2} \quad \text{when} \quad z < -\frac{L}{2} \text{ or } z > +\frac{L}{2} \quad . \ . \ . \ . \ . \ . \quad (19b)$$

Relation (19a) applies to unit beds which are between the two coils, while relation (19b) applies to unit beds which are outside of the interval between the two coils.

The value of G_z, as a function of z, is represented by the dashed line of Fig. 10, which will be referred to as the "vertical investigation characteristic." This curve shows the relative contribution of the different layers of ground.

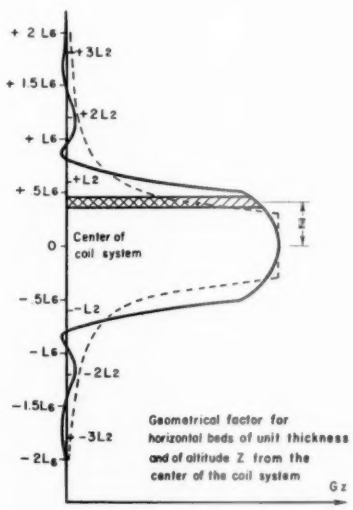


FIG. 10 — VERTICAL INVESTIGATION CHARACTERISTICS
- - - - TWO-COIL (SPACING L2)
———— FOCUSSING SONDE TYPE 6F (MAIN SPACING L6)

It is interesting to consider the geometrical factor of beds of finite thickness whose boundaries have a definite altitude with respect to the center 0 of the coil system. As an example, Fig. 11 shows the division of the ground in three regions, A, D and F. The region A, which is opposite the coil system, corresponds to a bed of finite thickness whose conductivity is to be measured, and which is referred to as "the bed." Regions D and F correspond to very thick beds which constitute what is generally referred to as "the surrounding formations." The geometrical factors G_A, G_D and G_F of the three regions, for the position of a coil system centered at o on Fig. 11, are measured, respectively, by the corresponding areas a, d and f under the vertical investigation characteristic. Taking into account the normalization already mentioned, which makes the geometrical factor for the whole space equal to unity, the geometrical factors G_A, G_D and G_F of beds A, D and F are given by:

$$G_A = \frac{a}{a+d+f} \quad . \ . \ . \quad (20a)$$

$$G_D = \frac{d}{a+d+f} \quad . \ . \ . \quad (20b)$$

$$G_F = \frac{f}{a+d+f} \quad . \ . \ . \quad (20c)$$

As can be seen from the figure, the geometrical factors G_D and G_F are far from being negligible unless the bed A is very thick. This means that the surrounding formations D and F can have appreciable influence, especially when they are more conductive than the bed A under investigation. It is for that reason that special coil combinations, referred to hereafter as "focussing systems", have been developed in order to minimize to a very large extent the effect of the surrounding formations, by reducing the corresponding geometrical factors.

Focussing Systems of Coils

It has been found that it is possible to obtain systems which have much better vertical investigation characteristics than two-coil devices. This is done through a proper combination of additional coils using special arrangements of spacings and numbers of turns. Fig. 10 shows, in solid line, the vertical in-

vestigation characteristic for a focussing system of coils (reference type 6F). It also shows, for comparison, and in dashed line, the vertical investigation characteristic for a two-coil combination. The spacing indicated for the focussing system is that of its two main coils, and is referred to as the "main spacing." The spacing for the two-coil system has been taken smaller than the main spacing of the focussing sonde to obtain a vertical investigation characteristic which corresponds as closely as possible to that of the focussing system. This, however, gives a slightly smaller lateral depth of investigation to the two-coil sonde, as shown in Fig. 12, where the radial investigation characteristics of both systems are shown. In spite of this reduction of spacing for the two-coil system, Fig. 10 illustrates that this system cannot compete with the focussing system when it is desired to minimize the effect of the surrounding formations, as, for instance, when measuring conductivity of a bed of small thickness. Provided that the bed thickness be more than 1.5 times the main spacing, the geometrical factor of the surrounding formations, as measured by the area under the vertical investigation characteristic, is extremely small for the focussing system. The use of the focussing system, therefore, results in more direct determination of the conductivity of the formations. It also results in a sharper determination of the boundaries.

In designing the focussing system whose vertical and radial characteristics are respectively given in Figs. 10 and 12, precautions were taken to reduce the geometrical factor for small radii, as illustrated by Fig. 12. This reduces, of course, in the same proportion, the influence of the regions of space, like the mud column and the invaded zone, which correspond to these small radii. With that type of coil system, the focussing, therefore, is both vertical and lateral.

The investigation properties of the focussing system of coils is further illustrated by Fig. 13, which is a chart of the unit geometrical factor for that system.* A comparison of this chart with that of Fig. 6 shows very clearly the advantages of the focussing system; namely, a sharper definition for the region of ground whose average conductivity is measured.

Geometrical Factor of a Given Region of Ground as a Function of the Position of the Coil System

The geometrical factor for a region of ground depends on its position with respect to the coil system. In practice, the region of ground is fixed, and it is the coil system that moves vertically along the hole. It is, therefore, normal to define the position of the coil system by the displacement of x of its center point with respect to a reference level. The geometrical factor G_A for a given region A of ground then becomes a function of x, which shall hereafter be written $G_A(x)$. Functions $G_A(x)$, $G_B(x)$, $G_D(x)$, etc. . . . can be tabulated for regions A, B, D, etc., of various shape

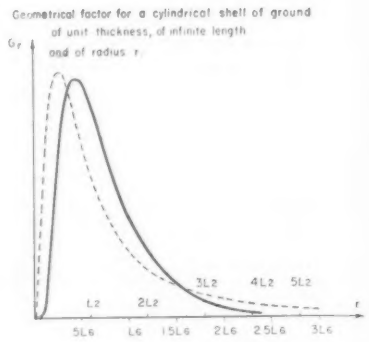


FIG. 12 — RADIAL INVESTIGATION CHARACTERISTICS
- - - - TWO-COIL (SPACING L2)
——— FOCUSSING SONDE TYPE 6F (MAIN SPACING L6)

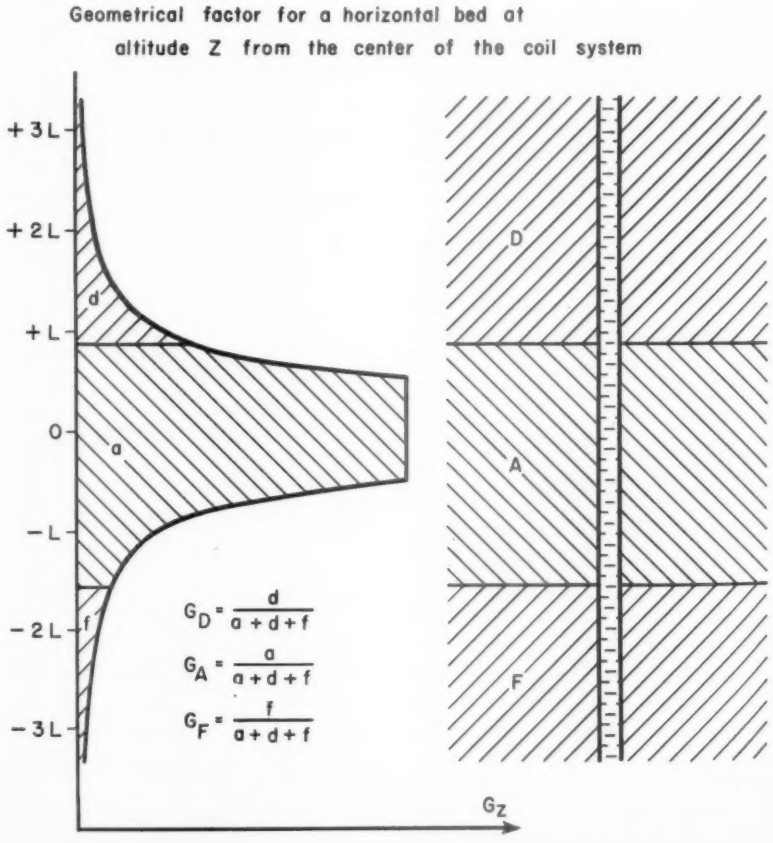


FIG. 11 — VERTICAL INVESTIGATION CHARACTERISTICS (TWO-COIL SYSTEM SPACING "L").

* Fig. 13 corresponds to an earlier type of focussing system, similar to present type 6F, but in which the focussing had been exaggerated with the consequence that certain regions show slightly negative g's. The corresponding chart for the present type 6F will probably be very similar, except that it will show less negative areas.

and dimension, and can then be used to compute typical logs or correction charts for various combinations of conductivities for the different media A, B, D . . .

THE MEASURED SIGNAL AND THE APPARENT CONDUCTIVITY

According to equation (9), the apparent conductivity for a given position of the coil system is given by:

$$C_a = C_A\ G_A + C_B\ G_B + \cdots \quad . \quad (21)$$

When the coil system moves along the hole, the geometrical factors G_A, G_B, etc., vary with the displacement x of the coil system. In that case, the expression for C_a becomes:

$$C_a = C_A\ G_A(x) + C_B\ G_B(x) + \cdots \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

Equation (22) shows that it is very easy to compute the "apparent conductivity logs" for any particular system of conductivities attributed to the media A, B, etc., once the functions $G_A(x)$, $G_B(x)$ . . . have been determined. The computation of the G factors by integration of equation (7), represents a substantial amount of work, since it has to be done for many shapes of ground types of coil system. It is, however, only a matter of time and, contrary to what occurs for analysis of electrical logs with electrodes, there is no theoretical difficulty which prevents the accurate computation of any particular case; the only requirement here is that there be symmetry of revolution. The consequence is that departure curves and correction charts can be computed for beds of finite thickness, whether invaded by the mud fluid or not, whatever the respective conductivities of the adjacent beds. Some examples of such departure curves or correction charts, corresponding to different coil systems or spacings, are given as examples in the next sections.

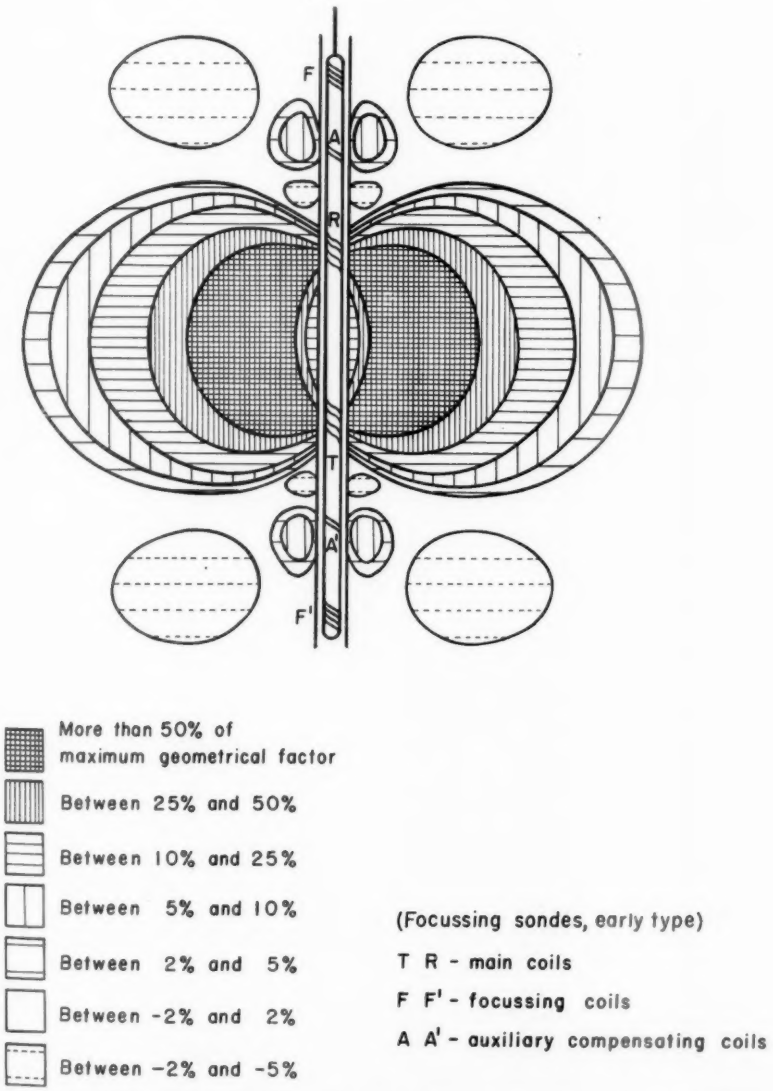


FIG. 13 — CHART OF THE GEOMETRICAL FACTOR FOR THE DIFFERENT REGIONS OF GROUND AROUND THE COIL SYSTEM.

Computed Logs and Departure Curves

The principles and formulae discussed in this paper have been used to compute induction logs and departure curves, corresponding to different distributions of ground conductivities, some of which are given here as examples. In all cases, it has been assumed that the mud was highly resistive, as is normally the case with oil base mud.

The logs of Figs. 14, 16, and the departure curves of Fig. 16 were established to compare the respective qualities of the two-coil device and the focussing system for the determination of the true resistivity of beds of finite thickness. In order to show the influence of bed thickness in its extreme aspect, beds that are less conductive than the surrounding medium were considered as not being invaded by the mud filtrate; otherwise, the effect of the surrounding formations, which corresponds to an increase of the apparent conductivity in that case, would be partially compensated by the effect of invasion, which corresponds to a decrease of the apparent conductivity. Conversely, beds which are more conductive than the surrounding formations were considered as invaded, because, in that case, both the invasion and the surrounding formations will tend to decrease the apparent conductivity.

Following the practice introduced in connection with electrical logging with electrodes, the curves given here are calibrated in resistivity units. Logarith-

mic scales are used for the resistivities on the logs and on the departure curves in order to show more clearly the percentage of departure of the apparent resistivities R_a with respect to the true resistivities R_t.

Both the computed logs of Figs. 14 and 15 and the departure curves of Fig. 16 verify that the two-coil system is much more sensitive to the influence of bed thickness, as expected, than the focussing device. Among the two coil systems, those having a spacing between one and two times the hole diameter seem to give the best over-all results, but the apparent resistivity differs appreciably from the true resistivity, even in beds whose thickness is sixteen times the hole diameter. This, however, is not too serious because corrections can be applied, as will be explained hereinafter.

The focussing system has the definite advantage of giving a good approximation to the true resistivity directly on the log. For the ground conditions assumed for Figs. 14 and 15, a main spacing between two and three times the hole diameter seems to give the best over-all results. The superiority of the focussing system over the two-coil system is well illustrated by Fig. 15, in which the logs corresponding to the best average spacing for both systems are superimposed. With the focussing type of sonde, corrections for bed thickness are practically not needed except for rather thin beds, in which case they can be made by use of special charts.

The departure curves of Fig. 16 show in a more complete form the information given by Figs. 14 and 15. On this figure, the left hand side corresponds to the two-coil system, and the right hand side to the focussing system. The full line curves correspond to the case of no invasion, whereas the dashed line curves are for invasion. It is particularly interesting to remark that there is no spacing for which the two-coil system is not too sensitive to bed thickness and to the conductivity of the surrounding formations. On the contrary, a focussing system with a main spacing from two to three times the diameter of the hole gives an apparent resistivity which is always between 80% and 125% of the true resistivity, as long as the bed thickness is more than five times the diameter of the hole and the surrounding formations have a conductivity not more than twenty times that of the bed. If the permeable beds are invaded by the mud fluid to a larger diameter D_i than that corresponding to the departure curves of Fig. 16, a larger spacing would be preferred, and the minimum thickness of the beds for good quantitative determination would be raised accordingly.

Correction Charts for Beds of Finite Thickness

Fig. 17, given here as example, is a correction chart for beds of finite thick-

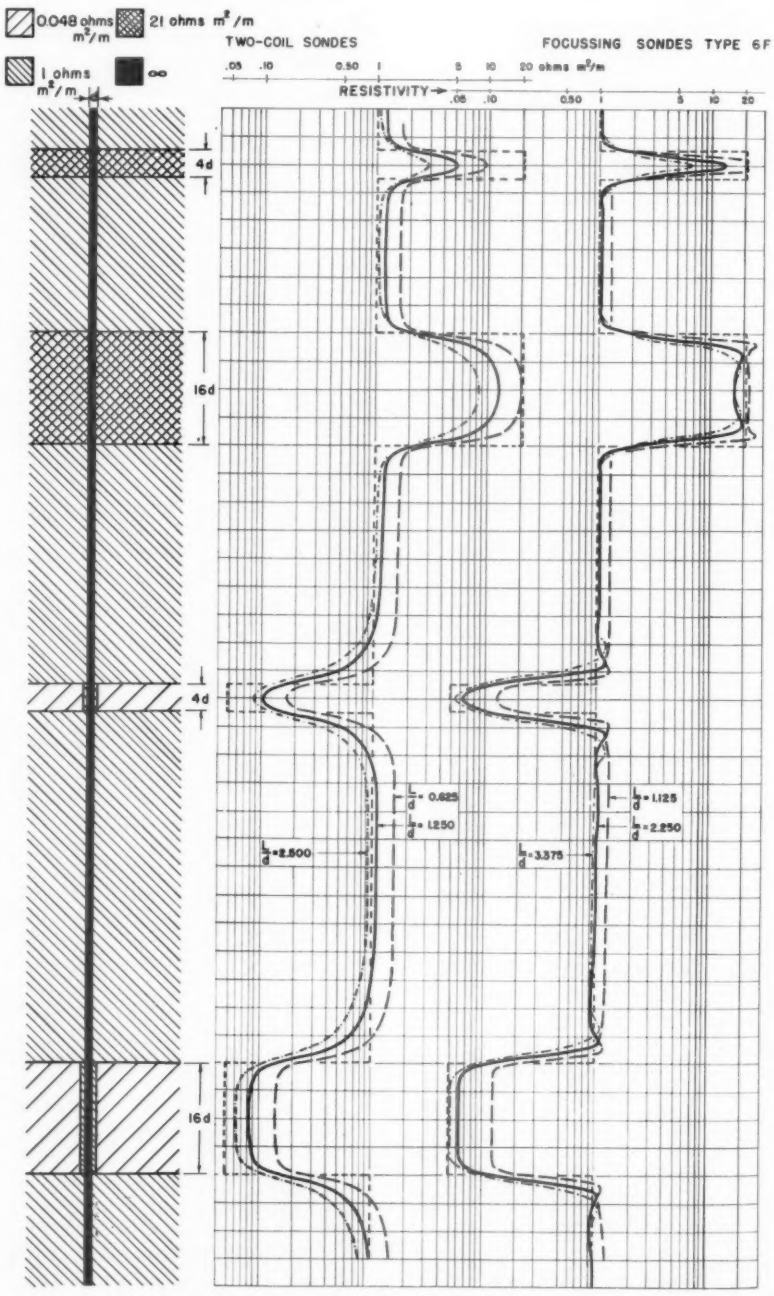


FIG. 14 — EXAMPLE OF COMPUTED INDUCTION LOGS FOR DIFFERENT VALUES OF RATIO SPACING "L".

ness, and corresponds to a two-coil system whose spacing is 1.25 times the hole diameter. Theoretically, such a chart applies only to a homogeneous bed of finite thickness surrounded by two homogeneous beds, referred to as surrounding beds, which are supposed to be very thick. This, of course, is an ideal case. Such charts are useful, however, even in the case of formations which are only approximately homogeneous, provided the surrounding beds are thick enough so that their average apparent resistivity can be determined from the log.

The chart has been calibrated in resistivity units, as done for the departure curves and the computed logs. It is, however, much easier to determine the necessary data from the induction log in conductivity units, for reasons that will be obvious. This is a quite logical choice, since the field logs are recorded with a linear scale for the conducitivities. In using the chart, the abscissae, which are expressed as the ratio of R_{sa}/R_a are then simply taken equal to C_a/C_{sa}, which has the same value.

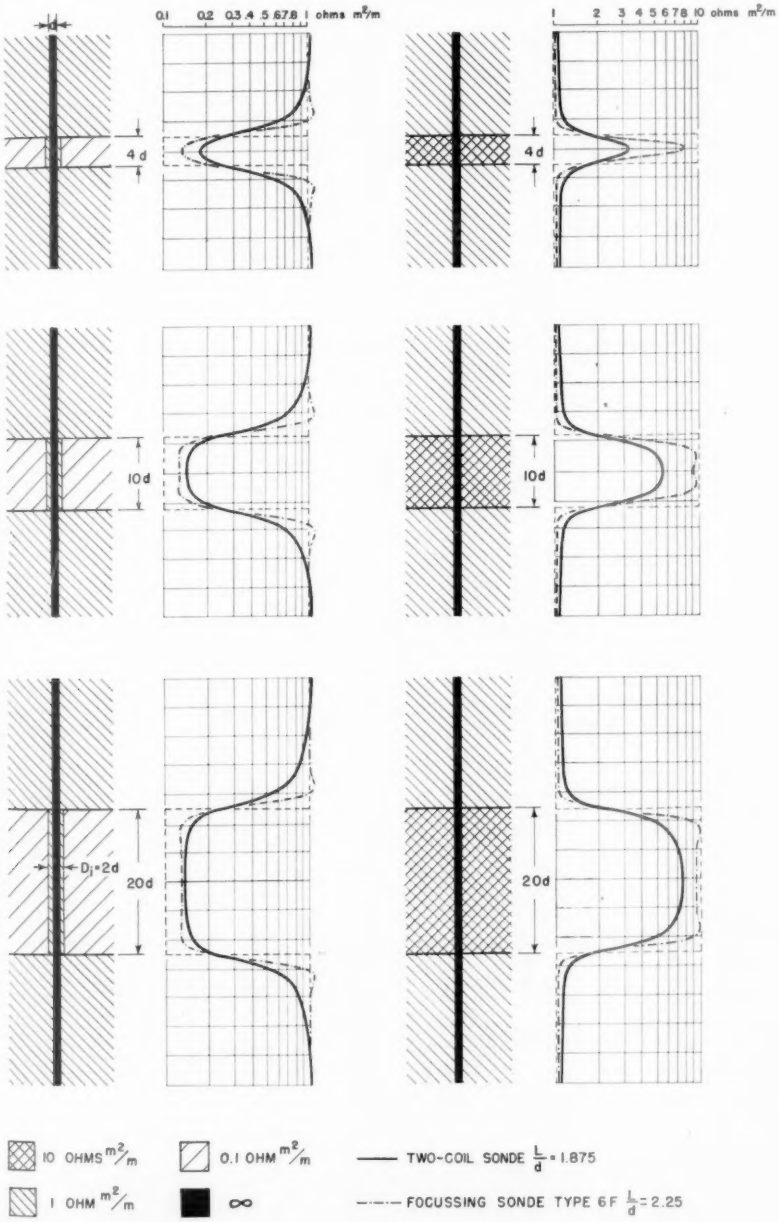

0.1 0.2 0.3 .4 .5 .6 .7 .8 1 ohms m²/m
1 2 3 4 5 6 7 8 10 ohms m²/m
4d
10d
20d
D = 2d
10 OHMS m²/m
1 OHM m²/m
0.1 OHM m²/m
∞
TWO-COIL SONDE L/d = 1.875
FOCUSSING SONDE TYPE 6F L/d = 2.25

FIG. 15 — EXAMPLE OF COMPUTED INDUCTION LOGS SHOWING COMPARISON BETWEEN A TWO-COIL SONDE AND A FOCUSSINB SONDE TYPE 6 F.

Fig. 18 shows schematically an induction log for a bed of finite thickness represented with a linear scale for the conductivities. It shows how the different data necessary for the use of the correction chart are determined from that log.

C_a is the apparent conductivity opposite the center part of the bed;

$C_{sa} = \dfrac{C_{sa1} + C_{sa2}}{2}$ is the average apparent conductivity of the surrounding formations;

h_a is the apparent* thickness, which is the difference between the two depths at which the conductivities are, respectively,

$$\frac{C_a + C_{sa1}}{2} \quad \text{and} \quad \frac{C_a + C_{sa2}}{2}$$

The value of C_a/C_{sa} is entered in abscissae on the correction chart, and the ratio R_t/R_a, or correction factor, is read on the ordinate scale for the curve corresponding to the thickness h_a.

When the logs have a linear scale for the resistivities, the boundaries determining h_a are taken at the depths where the apparent resistivity is equal to

$$\frac{2}{\frac{1}{R_a}+\frac{1}{R_{sa1}}} \quad \text{or} \quad \frac{2}{\frac{1}{R_a}+\frac{1}{R_{sa2}}}$$

Obviously, such determination is less practical than the one made on logs recorded with the linear conductivity scale.

The particular chart of Fig. 17 combines, for a given hole diameter and for a given coil system, the correction due to the bed thickness and the correction due to the highly resistive mud column. Other means can be conceived to take care of these corrections. In particular,

* The apparent thickness h_a, as determined from the log, is practically equal to the true thickness for beds whose thickness is at least three times the main spacing of the coil system.

the correction for the mud column can be done directly when recording the log, through proper adjustment of the scale, since the correction ratio is constant for a given hole diameter. Such adjustment steps will probably be developed commercially in the near future, and practical charts corresponding to the coil system actually used for the induction logging will be made available.

Correction Charts for Mud Filtrate Invasion

The value of R_t, as determined from the correction charts for beds of finite thickness, can further be corrected, if desired, for the effect of invasion, provided the diameter of invasion and the resistivity of the invaded zone can be estimated. Since the correction is generally not large, a fair estimation of these factors is sufficient in most cases.

Fig. 19 shows an example of a correction chart for mud fluid invasion corresponding to a two-coil system with a spacing of 1.25 times the diameter of the drill hole.

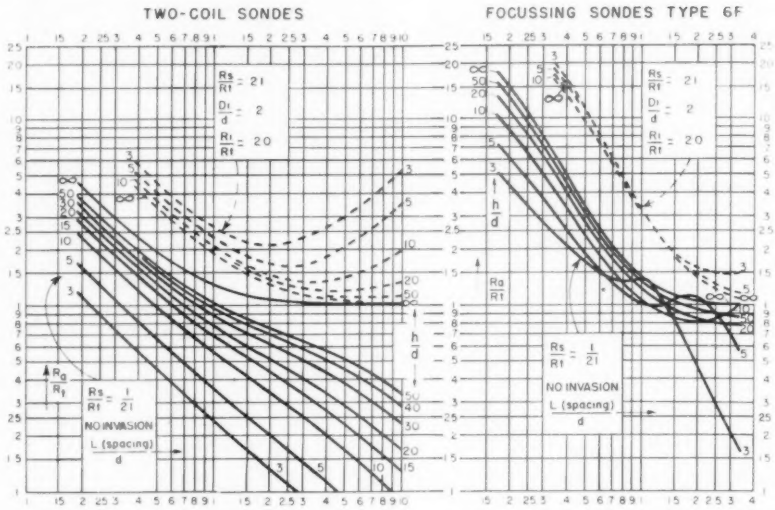


FIG. 16 — DEPARTURE CURVES FOR INDUCTION LOGGING IN OIL BASE MUD— BEDS OF FINITE THICKNESS.

d = hole diameter
h = bed thickness
Di = invaded zone diameter
L = spacing
Rt = bed resistivity
Ri = invaded zone resistivity
Ra = apparent bed resistivity
Rs = resistivity of surrounding formation

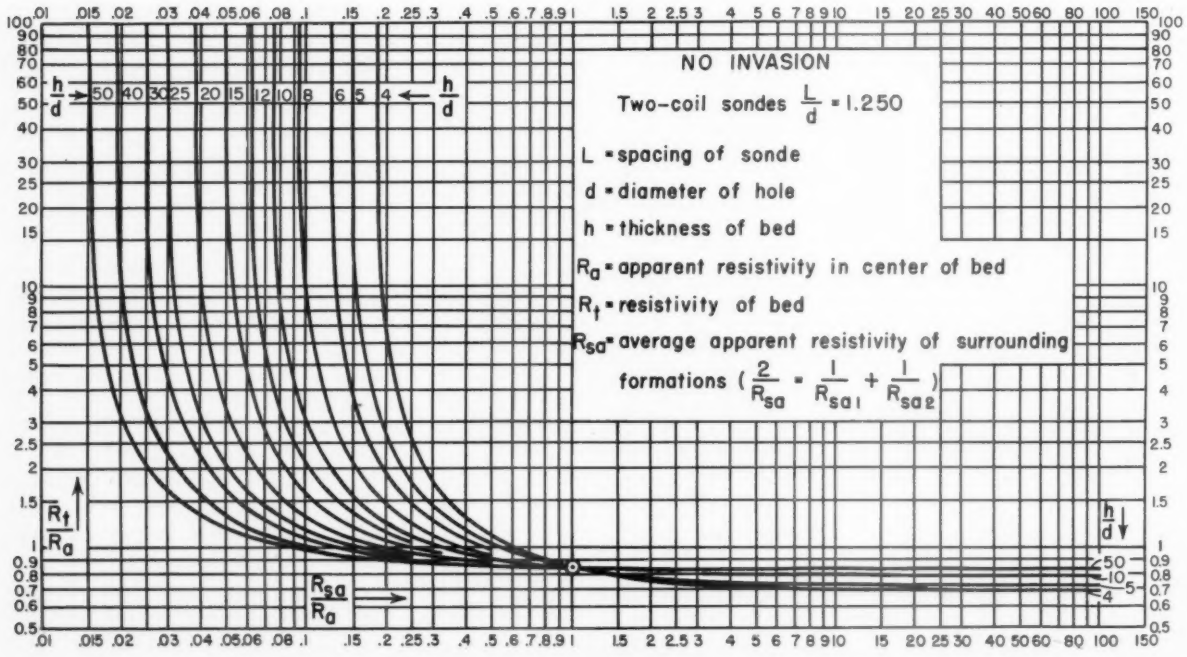

NO INVASION
Two-coil sondes L/d = 1.250
L = spacing of sonde
d = diameter of hole
h = thickness of bed
Ra = apparent resistivity in center of bed
Rt = resistivity of bed
Rsa = average apparent resistivity of surrounding formations (2/Rsa = 1/Rsa1 + 1/Rsa2)
h/d
Rt/Ra
Rsa/Ra

FIG. 17 — INDUCTION LOGGING IN OIL-BASE MUD, CORRECTION CHART FOR BEDS OF FINITE THICKNESS.

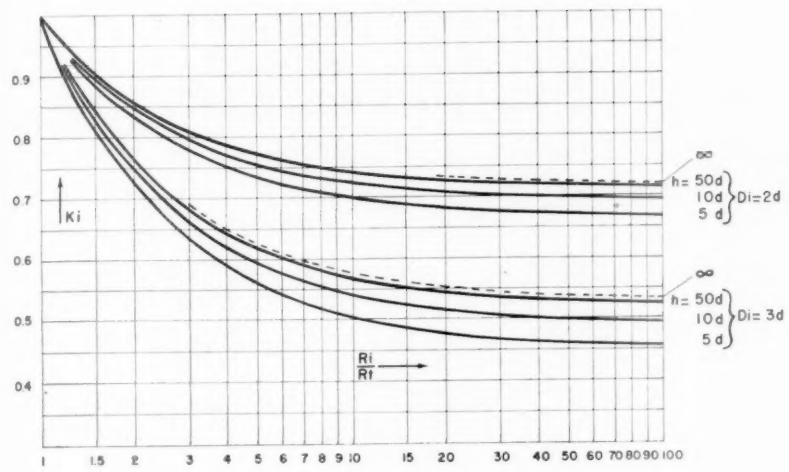


FIG. 19 — INDUCTION LOGGING IN OIL BASE MUD, BEDS OF FINITE THICKNESS. CORRECTION FACTOR FOR INVASION.

L
Two-coil sondes = 1.25
D

h = thicknes of bed
L = spacing of sonde

d = hole diameter
Di = diameter of invaded zone
Ri = resistivity of invaded zone
Rt = resistivity of formation (from chart for no invasion
Ki = correction factor
R Corrected = Ki x Rt

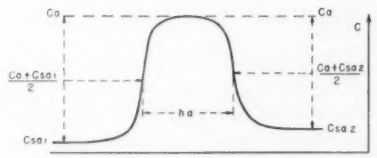


FIG. 18 — SCHEMATIC INDUCTION LOG SHOWING DETERMINATION OF APPARENT THICKNESS OF BED.

Numerical Examples of Quantitative Computations

Fig. 20 shows a computed log for a bed of finite thickness, corresponding to the same spacing as the examples of correction charts. This log is given to illustrate the method of correction. From the log, the following data is obtainable:

$C_a = 19.2$ mmhos/m or
$R_a = 52$ ohm-m
$C_{sa} = 1.9$ mmhos/m
$h_a = 4.2$ d

The correction chart of Fig. 17 for the entry with the value 10 for C_a/C_{sa} and the value 4.2 d for h gives $R_t/R_a = 0.7$, or R_t (assuming no invasion) = 52 x 0.7 = 36.4 ohm-m. This value of R_t is to be corrected for the effect of invasion where the diameter D_i and the resistivity R_i of the invaded zone can be estimated. Assuming for R_i and D_i the values 10 R_t and 2 d, as indicated on Fig. 20, the chart of Fig. 19 gives $K_i = 0.69$. Therefore, R_t (corrected for invasion) = 36.4 x 0.69 = 25.1 ohm-m, which corersponds very nearly to the true resistivity of 25 ohm-m for the bed, as used for the computation of the log.

Fig. 21 gives another example of a log, corresponding to a resistive bed without invasion. In that case:

$C_a = 190$ mmhos/m
$C_{sa} = 845$ mmhos/m
$h_a = 4.2$ d
$R_a = 5.3$ ohm/m

$$\frac{C_a}{C_{sa}} = 0.225$$

and the correction chart of Fig. 17 gives $R_t/R_a = 3.4$; therefore, $R_t = 5.3 \times 3.4 = 18$ ohm-m, whereas the R_t of the bed was 20 ohm-m.

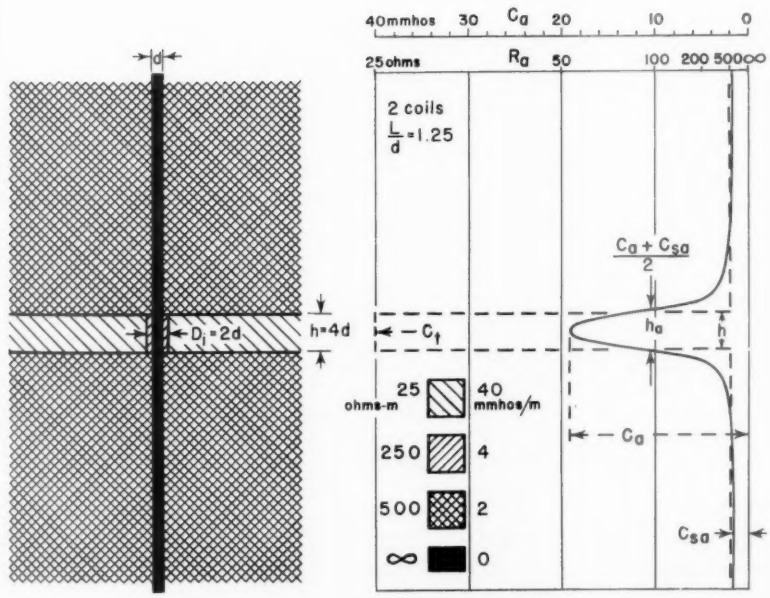


FIG. 20 — COMPUTED INDUCTION LOG SHOWING DETERMINATION OF APPARENT THICKNESS OF BED.

Remark on the Scale Calibration

The deflections recorded on field logs are proportional to the variations of the conductivity, and the scale is adjusted to a given number of mmhos/m, per division, by means of a test signal. In that respect, the calibration is, therefore, maintained accurate. In addition to the determination of the scale, it is necessary to position the zero on the logs. At present, this is accomplished by adjusting the apparatus when the sonde is located in the drill hole opposite a bed of very high resistivity, where the signal must be practically negligible. As the instrument is quite stable as long as it remains in the hole, the zero adjustment thus made is satisfactory for quantitative interpretation of strata of lower resistivity than that of the bed used for the adjustment. On the other hand, it would not be possible, with the present equipment, to obtain an accurate value of the conductivity of formations which are among the most resistive encountered in the open hole. Systems with a predetermined zero, sufficiently accurate for quantitative determination in all cases, are under development.

CONCLUSION

The conductivity, or the resistivity, of formations traversed by a drill hole can be determined by the induction logging method. This new technique is particularly useful at present for logging dry holes and holes filled with oil base mud, in which direct contact with the formations is difficult to establish.

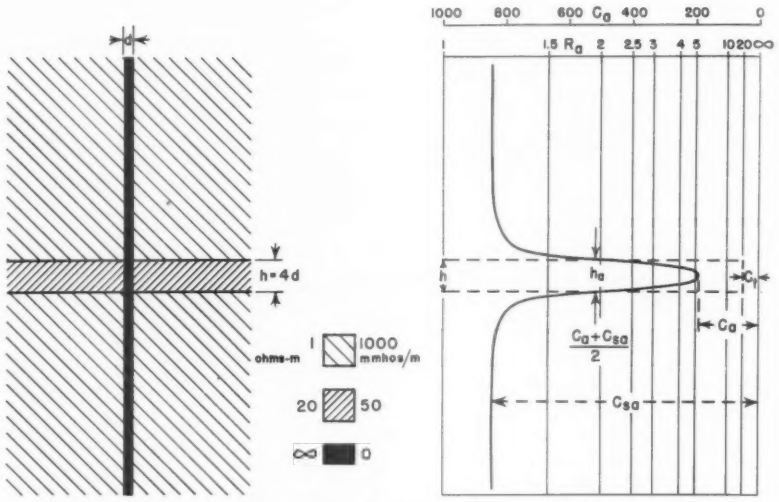


FIG. 21 — COMPUTED INDUCTION LOG FOR A NON-INVADED BED.

The method has great flexibility, and is quite promising. Coil systems can be designed to give a focussing effect in order to obtain directly on the log a more accurate value for the conductivity of beds of finite thickness.

Since the different regions of ground have generally a symmetry of revolution around the axis of the hole, and since, therefore, the induced currents have circular paths around that axis, the currents never cross the boundary from one region to the other. In these conditions, the contributions of the different regions to the measured signal can be considered independently. For that reason, it is relatively easy to compute typical logs and correction charts, which should greatly improve the possibilities of quantitative interpretation.

ACKNOWLEDGMENTS

The author wishes to acknowledge the valuable assistance of F. Perrin, A. Blanchard and A. Poupon, who worked on the mathematical computations; he also wishes to acknowledge the contribution of O. H. Huston who had an important part in the design and construction of the apparatus.

REFERENCE

1. Jahnke and Emde, *Tables of Functions and Formulae and Curves*, (Dover Publications, New York). ★

PRODUCTION OF OIL UNDER UNITIZATION IN WERTZ DOME FIELD, WYOMING

E. A. SWEDENBORG, U. S. GEOLOGICAL SURVEY, CASPER, WYOMING

ABSTRACT

The unit agreement for the Wertz Dome field, Wyoming, was approved by the Acting Secretary of the United States Department of the Interior on November 4, 1937, effective on December 1, 1937. The stated objectives of the agreement are to conserve and put to beneficial use all oil and gas produced; to make possible a uniform withdrawal of oil and gas in order to maintain equalized reservoir pressures; to provide for an orderly determination of the structural features of the productive horizons; and to permit the injection of gas for pressure maintenance. The purpose of this paper is to show by a discussion of the problems involved and the engineering practices employed by the unit operator, how well the objectives of the unit agreement have been accomplished in the development and production of oil and gas from the field.

HISTORY AND DEVELOPMENT

The Wertz Dome oil and gas field is located 88 miles southwest of Casper and 38 miles north and westerly from Rawlins, Wyoming. It is served by a state secondary oiled road connecting with U. S. Highway No. 220 at Lamont, a distance of 3 miles from the field. It has been a producing field for 27 years, first as an important producer of gas and more recently of oil.

The Producers and Refiners Corp. completed Well No. 1, NE¼SW¼ sec. 7, T. 26 N., R. 89 W., the first productive well in the field, in September, 1921, in the Muddy sandstone of Upper Cretaceous age, at a depth of 3435 feet for an initial production of 42,000,000 cu. ft. of gas per day. In 1922 pipe lines were laid to Casper, Wyoming, for supplying fuel to the Standard of Indiana refinery, the adjoining town of Mills, and the Producers and Refiners Corp. pump station No. 6 in Mills; and to Parco (now Sinclair), Wyoming, for supplying that refinery with fuel. The gasoline content of the gas was extracted in an absorption plant located near the town of Mills. No compressors were used as the line pressure was sufficiently high to flow the gas through the absorbers. As high as 30,000,000 cu. ft. of gas per day were treated in the plant extracting 6000 gallons of gasoline. In September 1937, the pipe line was discontinued and the plant was dismantled at which time 61,000,000,000 cu. ft. of gas had been produced from the seven Muddy, Cloverly, and Sundance gas wells drilled in the field. Of this volume of gas 800,000,000 cu. ft. were produced from the Frontier formation, 34,200,000,000 cu. ft. from the Muddy sandstone, 24,000,000,000 cu. ft. from the Cloverly, locally called Dakota, and 2,000,000,000 cu. ft. from the Sundance formation. The pipe line was discontinued because of the near depletion of the gas reserves in Wertz and nearby fields, and because of the local field requirements demanding the retention of the remaining gas reserves.

In December 1936, the Sinclair Wyoming Oil Co. completed Well No. 10, SE¼NW¼ sec. 7, T. 26 N., R. 89 W., at a depth of 5886 feet, as the first Tensleep sand producer with an intial of 1700 barrels of oil per day. The well was originally drilled only 14 feet into the sand and in August 1939 was deepened to a depth of 6161 feet, 289 feet in the sand, and the daily production increased to 8350 barrels of oil. In February 1948 Well No. 22, SE¼ SE¼ sec. 1, T. 26 N., R. 90 W., was deepened from the Tensleep to the Basal Amsden sand and completed at a depth of 6635 feet for an intial of 600 barrels of oil per day in the Basal Amsden. In April 1948, Well No. 2, SW¼ NE¼ sec. 1, T. 26 N., R. 90 W., was deepened from the Tensleep to the Madison limestone and was completed at a depth of 7193 feet for an intial of 1145 barrels of oil per day in the Madison. Well No. 26, SE¼SE¼ sec. 1, T. 26 N., R. 90 W., was deepened from the Tensleep to the Cambrian and in October 1948 it was completed in the Cambrian for an intial of 277 barrels of oil per day.

GEOLOGY AND PRODUCTIVE ACREAGE

The surface is Steele shale of Upper Cretaceous age, covered in part by gravel beds. The topography of the field is that of a rolling hill with a steep draw or gulch along the northern edge of the field. The Steele shale lies conformably on the lower formations as

Manuscript received at the Petroleum Branch Office January 20, 1949. Paper presented at AIME Annual Meeting in San Francisco, February 13-17, 1949.

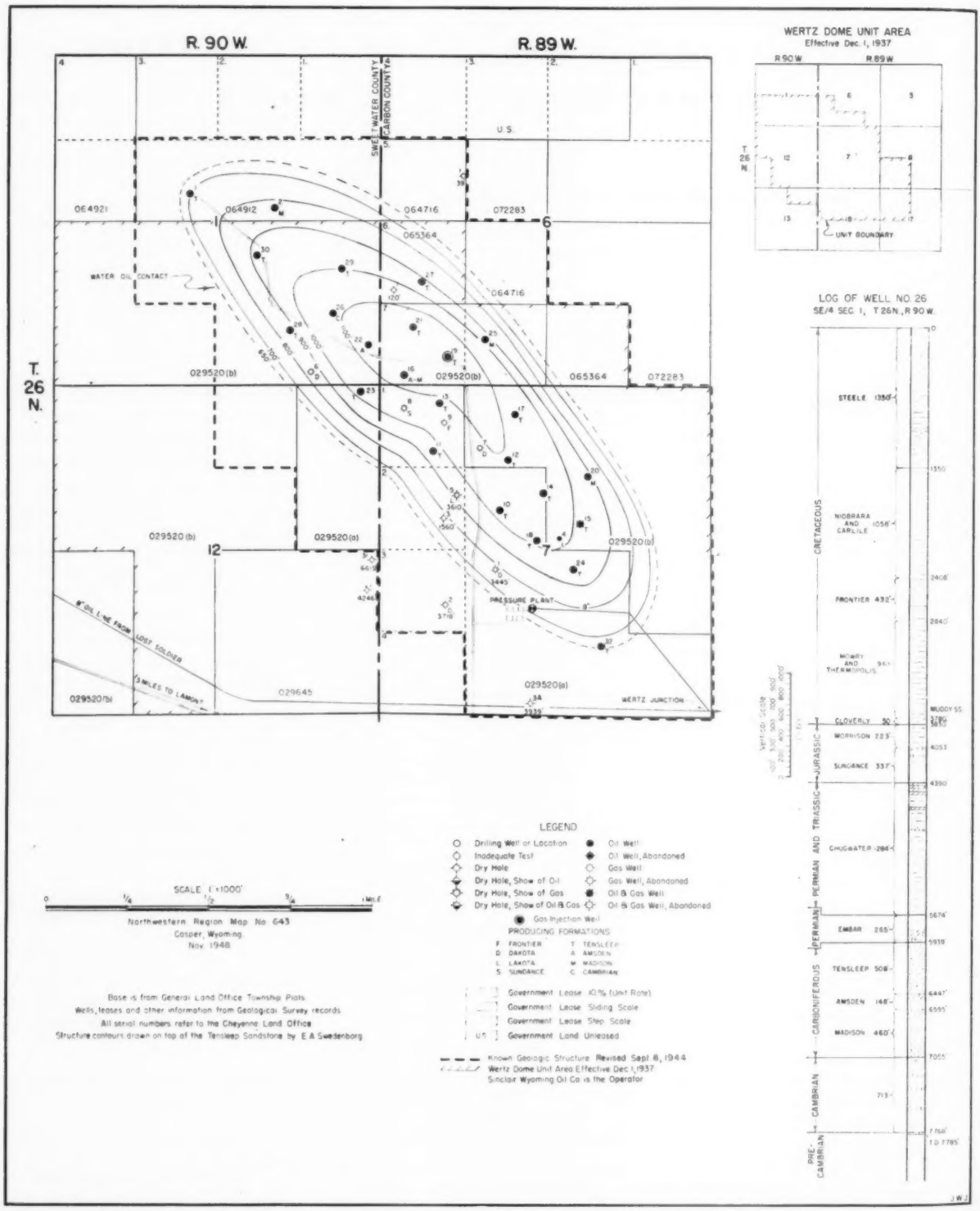


FIG. 3 — MAP OF WERTZ DOME, SWEETWATER AND CARBON COUNTIES, WYOMING.

TABLE I

Analysis of composite sample of gas produced with oil from Tensleep sandstone, Wertz Dome field, Wyoming:

	Per Cent by Volume
Oxygen	0
Nitrogen	4.09
Carbon dioxide	52.00
Hydrogen sulphide	1.11
Methane	26.80
Ethane	6.35
Propane	5.35
Iso Butane	0.79
Normal Butane	2.05
Iso Pentane	0.49
Normal Pentane	0.54
Hexane plus	0.43
Specific gravity by Pod:	1.241
Gross B.t.u. by Pod:	677

indicated on the log of Well No. 26, SE¼SE¼ sec. 1, T. 26 N., R. 90 W., shown on the accompanying map. The structure is a sharply folded anticline, 3 miles long and 1 mile wide lying across the boundary between Carbon and Sweetwater counties, Wyoming in Township 26 N., Ranges 89 and 90 West.

There is no state or patented land within the productive area and all mineral rights are vested in the United States and operations are subject to the Federal oil and gas operating regulations. The Tensleep reservoir has a proven productive oil area of 650 acres. The Amsden, Madison, and Cambrian formations have not been sufficiently drilled to determine the limits of production but it is believed that they extend over acreages somewhat smaller than that of the Tensleep sandstone.

TABLE II

Representative laboratory analysis of Tensleep oil, Wertz Dome field, Wyoming, by Casper laboratory of U. S. Geological Survey:

Per cent sulphur	1.33
API gravity	35.3
Pour point	Below 0°F.
Color	Greenish-brown

Distillation, Bureau of Mines, Hempel Method

Dry distillation; Barometer 635 mm.; First drop 26°C. (79°F.)

Temperature	Per cent cut	Sum per cent	Gravity of cut
Up to 122	2.8	2.8	89.6
122 to 167	3.3	6.1	82.2
167 to 212	4.0	10.1	71.5
212 to 257*	5.0	15.1	62.6
257 to 302	4.9	20.0	55.7
302 to 347	6.2	26.2	51.1
347 to 392	5.6	31.8	46.0
392 to 437	5.2	37.0	43.4
437 to 482	6.1	43.1	39.6
482 to 527	7.0	50.1	36.2
Vacuum distillation at 40 mm.			
Up to 392	2.4	52.5	32.3
392 to 437	6.6	59.1	30.6
437 to 482	6.0	65.1	27.9
482 to 527	5.2	70.3	25.6
527 to 572	5.9	76.2	23.0
Carbon residue of residuum:	9.5 per cent		
Carbon residue of crude:	2.6 per cent		

Approximate Summary

	Per cent	Gravity
Light gasoline	10.1	79.7
Total gasoline and naphtha	31.8	61.0
Kerosene distillate	5.2	43.4
Gas oil	20.9	35.4
Nonviscous lubricating distillate	10.8	
Medium lubricating distillate	6.3	
Viscous lubricating distillate	1.2	
Residuum	23.8	14.1
Distillation loss	0	

TENSLEEP SANDSTONE

The Tensleep sandstone thickness in four of the wells drilled through averages 450 feet, whereas in three of the wells wherein the sand was drilled through, it averages 540 feet. This fact along with similarity of crude oil, gas, and water found in the Tensleep, Amsden, Madison, and Cambrian formations indicates that at some time there may have been migration through faulting with respect to the above mentioned formations. See analyses of crudes from each formation. However there is no indication of faulting at the surface.

The Tensleep sandstone is found at depths ranging from 5800 feet on top of the structure to 6300 feet near the productive limits. The sand is hard and is composed of fine to medium grained sandstone streaked with dolomite. The fact that the sand is hard permits the cementing of casing on top of the sand leaving the well bore uncased through the sand section. No caving of sand has been experienced in any of the wells. The porosity of the sand varies from 3.3 to 18.9 per cent, averaging 14 per cent. The permeability ranges from 0 to 337 millidarcies with an average of 70 millidarcies. The connate water as determined by core analyses of cores taken from wells drilled, varies from a trace to 11 per cent, averaging 10 per cent for the oil saturated sand section.

DRILLING AND PRODUCTION

The drilling time of Tensleep sand wells has varied from three to five months depending on location of well on structure. The drilling of wells on the flanks of the structure required more time because weight on the drilling bit had to be reduced to keep the hole straight, and because of thickening of formations due to greater dip on flanks. The drilling was not done hurriedly since under the unit agreement there were no drilling requirements involving offset acreage which made possible an orderly determination of the structural features of the productive horizon. The market for the crude prior to 1941

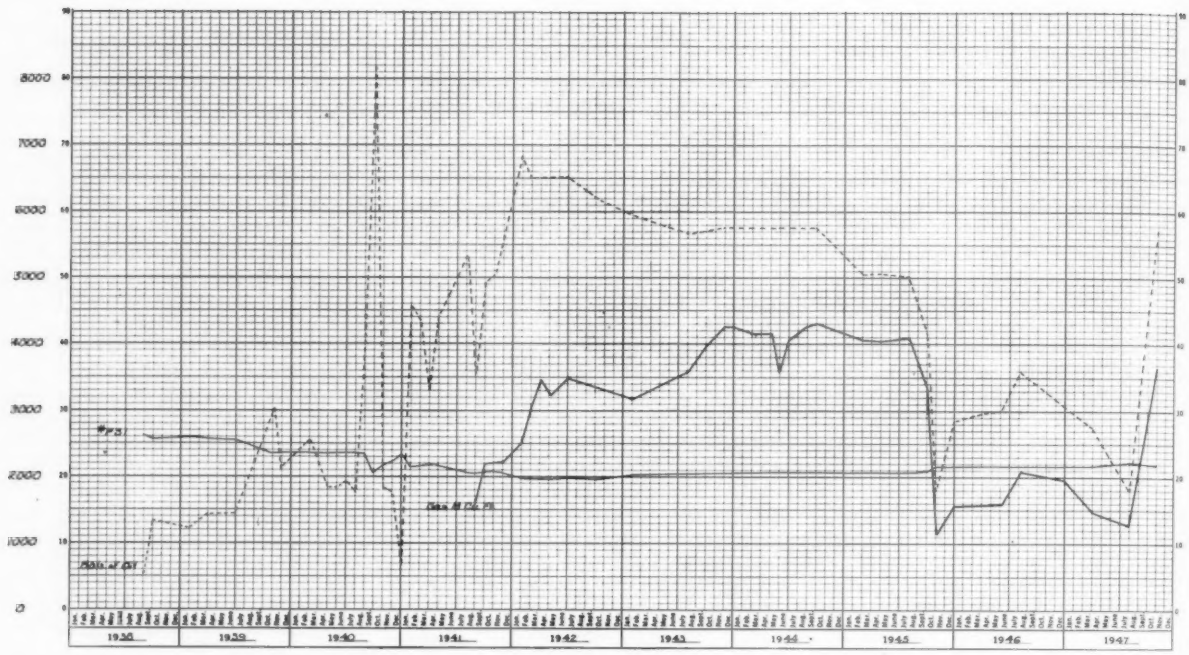


FIG. 1 — DAILY PRODUCTION, INJECTION AND B.H.P. IN THE WERTZ DOME TENSLEEP.

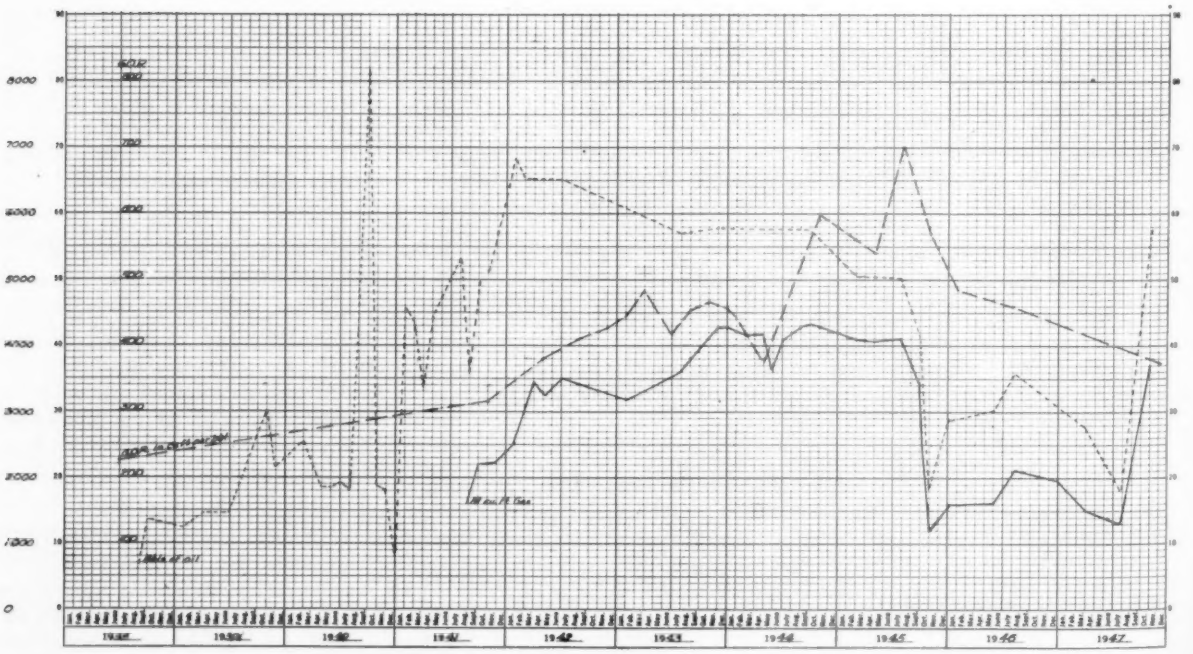


FIG. 2 — DAILY PRODUCTION, INJECTION AND G.O.R. IN THE WERTZ DOME TENSLEEP.

also restricted the development rate. One well was completed each year over the period of 1936 to 1940 inclusive. Ten wells were completed in 1941, five in 1942, and three in 1943. The continued demand for crude, prompted the testing of formations below the Tensleep sandstone in 1948 and upon finding oil in the Amsden, Madison and Cambrian formations, seven Tensleep wells were deepened. Six of the deepened wells were recompleted in the lower formations and one, an edge well, was plugged back and recompleted in the Tensleep after finding water in all formations below the Tensleep.

Twenty-five wells have been drilled to the Tensleep; one was outside of the producing limits and one at the water oil contact. Twenty-four were producers ranging in productive capacities from 35 barrels of oil per day on the pump to 8350 barrels of oil flowing. Twenty wells were good flowing producers of oil whereas four wells along the northern flank were small producers and were pumped. The four pumping wells were the last drilled in the field and had small amounts of water with the oil, but did not flow because the bottom hole pressure of the reservoir had been reduced to or was approaching 2000 psi, which is the minimum pressure required for natural flow of oil for wells of their depth considering the temperature and specific gravity of the crude produced.

It had become obvious by 1940, as the result of flowing production at various rates and observing drop in bottom hole pressures, that it would not be long before all the wells would be placed on artificial lift or, the producing rate drastically reduced to equal the rate of water encroachment in order to utilize hydrostatic pressure. The question of injecting the Tensleep gas produced with the oil was considered but in as much as the produced gas had a carbon dioxide content of 52 per cent and hydrogen sulphide content of 1.11 per cent, the problem of corrosion was a serious one in compressing the gas to pressures necessary for injection. (See analysis of gas.) The Sinclair Wyoming Oil Co., unit operator, decided on a method of dehydrating the gas to prevent corrosion rather than removal of the hydrogen sulphide and carbon dioxide. The decision has been proven sound as the corrosion of equipment in the compression of the dehydrated gas has not been serious over a period of 7½ years of operation. The dehydration method also avoided shrinkage of gas volume that would have resulted from the removal of corrosive components in the gas.

TABLE III

Representative laboratory analysis of Amsden oil, Wertz Dome field, Wyoming, by Casper laboratory of U. S. Geological Survey:

Per cent sulphur	0.36
API gravity	35.4
Pour point	Below 5°F.
Color	Greenish-brown

Distillation, Bureau of Mines, Hempel Method

Dry distillation: Barometer 636 mm.; First drop 29°C. (84°F.)

Temperature	Per cent cut	Sum per cent	Gravity of cut
Up to 122	2.8	2.8	89.6
122 to 167	3.4	6.2	81.9
167 to 212	4.2	10.4	70.9
212 to 257	5.0	15.4	62.6
257 to 302	5.4	20.8	55.2
302 to 347	6.1	26.9	50.6
347 to 392	4.8	31.7	46.7
392 to 437	5.4	37.1	43.2
437 to 482	6.0	43.1	39.6
482 to 527	7.4	50.5	35.8
Vacuum distillation at 40 mm.			
Up to 392	2.3	52.8	32.5
392 to 437	6.2	59.0	31.0
437 to 482	5.7	64.7	28.2
482 to 527	5.9	70.6	25.4
527 to 572	5.8	76.4	23.2
Carbon residue of residuum:	9.6 per cent		
Carbon residue of crude:	2.57 per cent		

Approximate Summary

	Per cent	Gravity
Light gasoline	10.4	79.4
Total gasoline and naphtha	31.7	61.3
Kerosene distillate	5.4	43.2
Gas oil	20.6	35.4
Nonviscous lubricating distillate	10.9	30.6-25.0
Medium lubricating distillate	6.2	25.0-22.5
Viscous lubricating distillate	1.6	22.5-21.8
Residuum	23.4	14.1
Distillation loss	0.2	

PRESSURE MAINTENANCE PLANT

Three Cooper-Bessemer 600 hp gas engine-compressor units boost the gas from an intake pressure of 30 pounds to a discharge pressure of 1825 pounds. The engines are of the six-cylinder, two cycle, angle type, with three compression cylinders each. The gas is boosted in three stages with the compressors operating in parallel through a common header system. In the first stage the pressure is boosted to 140 pounds, in the second to 485 pounds, and in the third and final stage to 1825 pounds. Check valves in the final stage discharge lines protect the plant should the final stage go out and permit the field pressures to back up in the gas return system.

Dehydration of the gas takes place between the first and second stages of compression, and is accomplished by

passing the gas through a column containing one flourite and three activated alumina beds. There are two of these columns operating in alternate 24-hour periods, one being reactivated while the other is in use. The columns are reactivated by cycling preheated gas through them to take up the water vapor from the beds, and then cooling the gas and collecting the resulting condensate in a receiving tank for removal from the system. Gas in the system is dehydrated to a dew point of 14°F. below zero at the discharge pressure of 1825 pounds.

The plant is semi-automatic, and ordinarily only one man is needed on each shift. An electrically operated emergency shut down system has been provided. Switches have been placed at three convenient points in the plant and yard and pulling any one of these cuts off the fuel to the boiler, quenches the boiler fire boxes with steam, shorts the magnetos on the engine, shuts off the incoming gas and turns all production through the separtors direct to storage instead of through the plant. Man power requirements for the operation of the plant are at a minimum. Because of severe cold weather during the winter months, all equipment is enclosed in steel buildings which are heated by exhaust steam from the turbines which drive the electric generators thereby maintaining a uniform temperature in the buildings.

Production of both oil and gas is delivered directly to the plant. The crude oil is passed through two banks of oil to oil heat exchangers and a steam heater to a flash tower for stabilization of the crude. The crude stream from the flash tower is cooled, first in the heat exchangers with the incoming cold crude and then in a final water to oil cooler from which it goes to storage. Approximately 70 per cent of the gas produced with the oil is taken off at the oil and gas separators. The remaining gas is vented from the flash tower in the stabilization of the crude and is delivered with the gas from the separators to the intake of the low stage compressors. This method of delivering the oil and gas direct to the plant from the wells for stabilization prevents any loss of oil vapors by evaporation. In reality the gravity of the oil is increased in the stabilization process. The light gasoline fractions obtained in the compression of produced gas to injection pressures are added to the oil stream as it goes to the tanks for pipe line shipment.

PRODUCTION AND PRESSURE MAINTENANCE

Production schedules have been restricted at rates below 6000 barrels per day since 1942. During the years 1943, 1944 and 1945 the average daily rate was approximately 5500 barrels and during 1946 and 1947 the daily rate averaged 3000 barrels. In 1948 the rate was again increased to approximately 5500 barrels per day.

Until gas injection into the Tensleep sandstone was started, a free gas cap was not present in the reservoir. The oil was under-saturated with gas. The original gas-oil ratio was 210 cu. ft. per barrel of oil. Since gas has been returned to the formation the gas-oil ratio has fluctuated depending on injection volumes, producing rates and shutting in of wells high on structure. See graph, Fig. 2. By progressive control in high-structure wells as their respective ratios increased, the average gas-oil ratio has been held within reasonable limits, thus

TABLE IV

Representative laboratory analysis of Madison oil, Wertz Dome field, Wyoming, by Casper laboratory of U. S. Geological Survey:

Per cent sulphur	1.28
API gravity	35.2
Pour point	Below 0°F.
Color	Greenish-brown

Distillation, Bureau of Mines, Hempel Method

Dry distillation; Barometer 635 mm.; First drop 27°C. (81°F.)

Temperature	Per cent cut	Sum per cent	Gravity of cut
Up to 122	2.7	2.7	88.9
122 to 167	3.3	6.0	81.9
167 to 212	4.0	10.0	70.9
212 to 257	5.2	15.2	62.6
257 to 302	4.6	19.8	55.7
302 to 347	6.2	26.0	50.0
347 to 392	4.9	30.9	46.9
392 to 437	5.3	36.2	43.4
437 to 482	5.8	42.0	39.8
482 to 527	7.3	49.3	36.0
Vacuum distillation at 40 mm.			
Up to 392	1.9	51.2	32.3
392 to 437	6.6	57.8	30.8
437 to 482	6.5	64.3	28.0
482 to 527	5.7	70.0	25.6
527 to 572	6.6	76.6	22.8
Carbon residue of residuum:	10.1 per cent		
Carbon residue of crude:	2.7 per cent		

Approximate Summary

	Per cent	Gravity
Light gasoline	10.0	79.1
Total gasoline and naphtha	30.9	61.3
Kerosene distillate	5.3	43.4
Gas oil	20.5	35.4
Nonviscous lubricating distillate	11.4	29.8-25.0
Medium lubricating distillate	7.0	25.0-22.0
Viscous lubricating distillate	1.5	22.0-21.3
Residuum	23.3	13.3
Distillation loss	0.1	

TABLE V

Representative laboratory analysis of Cambrian oil, Wertz Dome field, Wyoming, by Sinclair Refinery, Sinclair, Wyoming:

Gravity	36.1	
Sulphur	1.39	
		Grav.
Over to 330	19.9	66.3
330 to 400	10.0	50.6
400 to 520	15.3	41.3
520 to Off	13.6	33.3
Tests on Bottoms:		
Gravity	19.0	
Visc. @ 210 S.U.	.70	
Sulphur	2.33	

1600 cc Distillation: Temperature Sea Level	Sinclair	% Evaporated
140	129	2.13
160	148	3.44
180	168	5.18
200	187	6.94
220	207	9.06
240	227	11.00
260	246	12.9
280	266	14.4
300	286	16.9
320	305	18.7
330	315	19.9
340	325	21.3
360	344	24.6
380	364	27.3
400	383	29.9
420	403	32.2
440	423	34.7
460	442	37.3
480	462	39.8
500	482	42.3
520	502	45.2
540	521	47.5
560	541	50.0
580	560	53.0
620	600	58.8

avoiding the necessity of handling excessive volumes of gas.

The volume of gas produced from the Tensleep formation is not sufficient to maintain desired formation pressure, consequently gas from the Cloverly and Sundance sand wells is used to make up any deficiency in volume needed to maintain volumetric balance in the reservoir.

Gas injection was started in July 1941 and has been continued since then. As of December 31, 1947, 7,043,000,000 cu. ft. of gas have been injected into the Tensleep sandstone. Of this, 4,668,800,000 cu. ft. were gas produced with the oil and reinjected and 2,374,800,000 cu. ft. make up gas produced from sands above the Tensleep sandstone. It is estimated that there are 5,442,800,000 cu. ft. of gas in the gas cap on top of the structure as of December 31, 1948. Although 7,043,600,000 cu. ft. have been injected, 1,600,800,000 cu. ft. of that volume is gas that has been recycled in the process of production and reinjection. Average pressure at this time is 2140 pounds, which is 190 pounds over the low of 1950 in 1942. See graph,

TABLE VII

Tensleep Sandstone Production by Wells and by Years

Well No.	Location	Completion Date	1937–38	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	Total Bbls. Oil
10(a)	NW sec 7	12–20–36	232238	295127	238098	202976	165500	189408	232854	179122	105577	133557	134062	2,018,519
11(a)	NW sec 7	11–21–37	126602	143343	194154	191452	175399	221399	210668	168342	103562	116709	193093	1,844,306
12-B	NW sec 7	4– 4–38	101527	163826	209121	202061	175401	142088	134568	60738	28768	49697	89991	1,357,786
13-a	NW sec 7	7–24–39		158559	220808	192314	121486	46153	39074	26549	25206	21713	8937	860,799
14	NW sec 7	8–10–40			166419	202746	175408	163403	127598	88828	94833	108733	111995	1,239,963
15	SE sec 7	2–11–41				155120	175414	120818	99429	150833	94363	71598	75391	942,966
16	SW sec 6	1–15–41				164537	121500				5180	9937	1400	302,554
17	NW sec 7	5– 8–41				117567	175410	121958	75116	43093	54607	56861	41580	686,222
18	NW sec 7	4– 3–41				204489	175441	234953	23657	57194	4328	66264	164778	1,144,026
19	SW sec 6	5–13–41				31653								31,653
20	NE sec 7	7–24–41				64534				600	6653	7470	2095	81,352
21	SW sec 6	9–15–41				52858	144105	22034	257					219,254
22	SE sec 1	8– 7–41				64411	175527	80672	26148	21117	14920	10150		392,945
23	NE sec 12	8–23–41				59905	175532	196807	162000	153687	122946	124710	211037	1,206,624
24	SE sec 7	4–17–42					118811	115922	140122	108188	101888	92284	160216	841,431
25	SW sec 6	1–25–42					674	17571	14150	23968	8780	12362	5016	82,521
26	SE sec 1	12–16–41				640	162144	108408	123380	95669	47383	32118	16932	586,674
27	SW sec 6	3–12–42					20669	68454	90100	81653	75019	63023	82500	481,418
28	SE sec 1	12–17–42					7114	155118	180703	136789	107526	125161	185999	898,410
29	SE sec 1	10–20–42					8211	18338	28564	21952	43339	28045	50512	198,961
30	SE sec 1	8–19–42					42724	58905	98774	84584	81158	91352	166369	623,866
32	SE sec 7	8–28–43								9			1522	1,531
1*	NW sec 1	4– 4–43						3271	14631	16551	16236	13975	14327	78,991
2*	NE sec 1	11–15–46										2657		2,657
	Total		460367	760755	1028600	1907263	2316500	2085363	2034715	1519466	1145272	1239376	1717752	16,215,429

*Outside unit area.

Fig. 1. Production prior to the starting of gas injection in July 1941 totaled approximately 3,400,000 barrels of oil. Original reservoir pressure was estimated at 2600 lbs. psi. By the time pressure maintenance was started the pressure had dropped to 2040 pounds, a drop of 560 pounds. As a result of pressure maintenance and restricting producing rates the reservoir pressure as of December 31, 1947, was 2134 pounds with a total oil production as of that date of 14,410,260 barrels. A total of 11,010,260 barrels of oil has been produced since July 1941 when gas injection was started up to December 31, 1947. During the period, the reservoir pressures increased approximately 100 lbs. psi whereas before the pressure maintenance program was started, only 3,400,000 barrels were produced, with a reservoir drop of 560 lbs. psi.

Two injection wells were used for a time but at present only one well is used. The original well is located on top of the structure, while the second well, now discontinued, is located about 250 feet down structure. The down structure injection of gas was somewhat of a departure from general practice in the early history of a pressure maintenance program. It was thought that by down structure injection, gas would have an opportunity to saturate the under-saturated oil with gas in its movement up structure, and in so doing reduce the viscosity of the oil and stimulate its movement to producing wells. However, it was found that eventually the gas injected in the down structure well channelled to adjoining wells and its use was discontinued. The volume of gas injected has been guided by the rate of oil withdrawal. It is calculated that 3000 barrels of water per day move up structure to replace oil withdrawn at a reservoir pressure differential of 460 lbs. psi. This calculation is based not only on graph, Fig. 1, but also on a volumetric balance of fluids produced as against fluids in place in the reservoir. The water head is equivalent to 2600 lbs. psi as indicated by reservoir pressure prior to oil withdrawal. Therefore, when oil is produced at a rate in excess of 3000 barrels per day, an equivalent volume replacement in the reservoir has to be made by gas injection in order to stabilize the reservoir pressure some where near 2140 lbs. psi. (See graph, Fig. 1). It has been stated previously in this paper that a minimum of 2000 lbs. psi reservoir pressure is required to maintain flow of the wells in the field. It is therefore important that the reservoir pressure be maintained at some pressure in excess of 2000 lbs. psi. It is estimated that 1200 cu. ft. of gas is required to replace one barrel of oil under reservoir conditions. This estimate is based on bottom hole samples and field tests made by the unit operator.

The success of the gas injection program in the Wertz Dome field is attributable to the maintenance of a volumetric balance between oil withdrawal, gas injection and edgewater encroachment at a reservoir pressure that will support the flowing of production and yet utilize some energy of the hydrostatic head. Maximum recovery will not only be realized as a result of the maintenance of such a program, but it will make possible a depletion of the oil in the reservoir at a much shorter period of time than would be ordinarily required, and at considerably less cost.

The unit operator is employing practices that are beneficial to the participants in the unit agreement. Everything is being done to promote economical and efficient development of the field, and to insure efficient recovery of the unitized substances to the end that the maximum ultimate yield may be obtained without waste. The benefits of unitization with respect to operations in the Wertz Dome field may be summarized as follows:

1. Realization of maximum economical recovery of oil.

2. The gas produced with the oil has been conserved and utilized in spite of its character. Ordinarily it would have been largely wasted if not used in pressure maintenance of the reservoir.

3. Elimination of offset wells resulting in wells being advantageously located on structure.

4. Retention of the wells in a flowing status by maintaining a reservoir balance.

5. Provides a fair distribution of revenue from oil produced to the parties entitled to share in it.

TABLE VI

Representative analysis of Tensleep sandstone water, Wertz Dome field, Wyoming, by Casper laboratory of U. S. Geological Survey:

	Parts per million	Reacting value	Value in per cent
Sodium and Potassium (calculated as Sodium)	2456	106.82	40.35
Calcium (Cal)	433	21.61	8.16
Magnesium (Mg)	48	3.95	1.49
Sulphate (SO4)	3838	79.83	30.15
Chloride (Cl)	1302	36.72	13.87
Bicarbonate (HCO3)	965	15.83	5.98

Total solids in parts per million	
By evaporation	8400
After ignition	8260
Calculated	8552

Properties of reaction in per cent	
Primary salinity	80.70%
Secondary salinity	7.34%
Primary alkalinity	0.00%
Secondary alkalinity	11.96%
Chloride salinity	31.51%
Sulphate salinity	68.49%

ACKNOWLEDGMENT

The writer wishes to acknowledge the assistance and helpful suggestions of Supervisor J. R. Schwabrow and the engineers and draftsman in the Northwestern Regional Office, Oil and Gas Leasing Branch, Conservation Division, United States Geological Survey; and F. H. Rhees, Division Superintendent, and other personnel of the Sinclair Wyoming Oil Co. ★ ★ ★